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Mariners Weather Log

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Cover: An island of logs in the middle of the Pacific Ocean provides a resting place for a few survivors (circled) of the sunken Panamanian freighter CARNELIAN-1. The vessel went down in a severe November storm about 1,400 mi northwest of Honolulu. For a description of the storm, see Rough Log, North Pacific Weather, November 1976. U.S. Coast Guard Photo.

Mariners Weather Log

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Editorial Assistant: Annette Farrall

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The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical approved by the Director of the Office of Management and Budget through June 30, 1980.

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Mariners Weather Log

FOULING

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Fouling in the marine environment has been a major problem ever since man has been using boats of a size not easily removed from the water. There are two methods of controlling fouling--mechanical and chemical. The fouling growth can be scraped off at regular intervals,or coatings of chemicals which are toxic to fouling organisms can be applied to exposed surfaces. For obvious reasons, this latter prevention method has had widest application and shows greatest promise. Use of chemical deterrents date to as early as the 5th Century B.C. when coatings of arsenic and sulfur mixed with oil were used, while lead sheeting was used as early as the 3d Century B.C.

Biological fouling and deterioration of materials in the marine environment are estimated to have cost the U.S. Navy more than $215 million in 1973. While this total includes deterioration of wood docks and piers, a significant portion of the expenditure is due to fouling growth on ship hulls alone (fig. 1). This figure does not include the cost of impaired perfor-

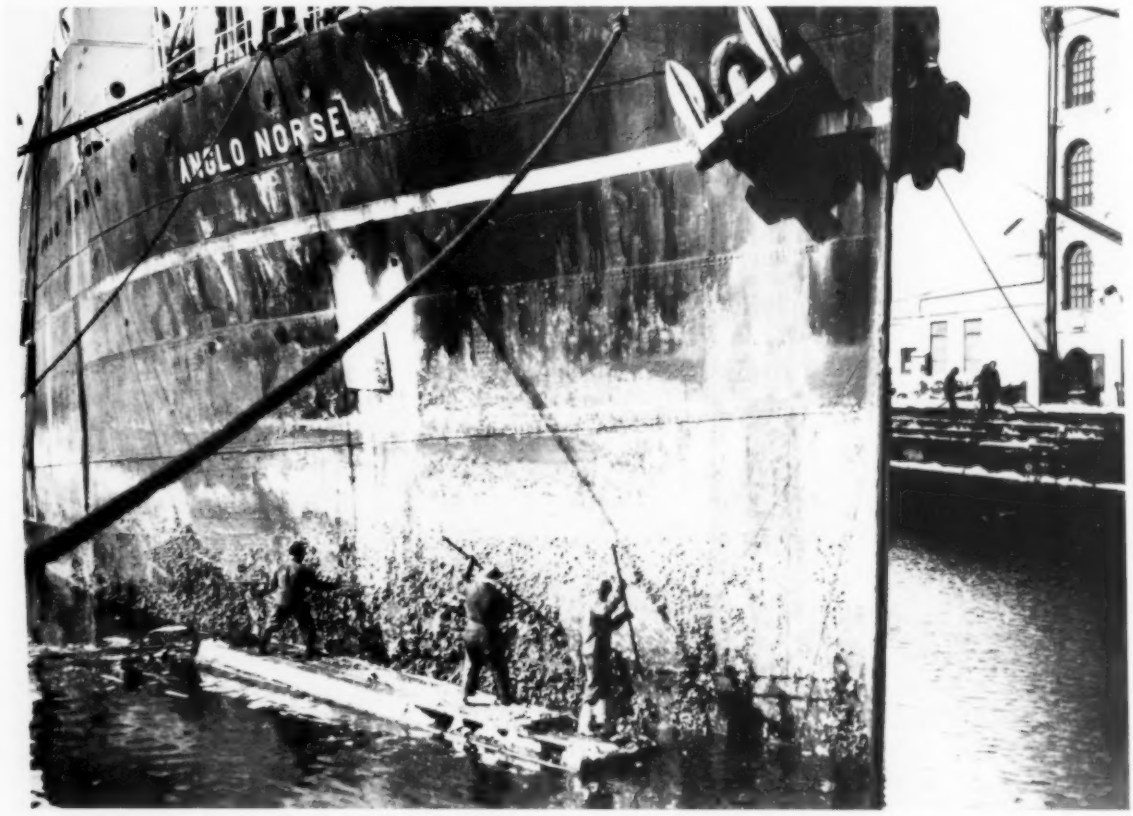

Figure 1.--Barnacles are being removed from the heavily encrusted hull of the ANGLO NORSK. It is easily seen how a ship's speed would be reduced by such growth. Photo courtesy of Todd Shipyards Corporation.

Figure 2.--Fixed objects in coastal waters are particularly susceptible to fouling.

mance, out-of-service time, reduced service life, loss of reliability, or initial costs of antifouling measures. For example, prior to World War II, design allowances for increased drag of ship hulls due to fouling accumulation included a 3-percent increase in fuel consumption per month. Fixed objects, such as piers, buoys, near-shore bottom installations, offshore platforms, and anchored vessels, are especially susceptible to fouling (fig. 2). Estimated annual costs to the United States for the repair of underwater structures range from $200 to $250 million. While ships are a prime candidate for fouling, particularly while in port and in warm coastal waters, fixed marine structures are extremely vulnerable. The fields of corrosion and marine fouling overlap significantly in that the only metals which resist the establishment of fouling communities are those which corrode and, in doing so, release toxic corrosion products.

MECHANISM AND TYPES OF FOULING

Marine fouling involves the attachment and growth of marine plants and animals on surfaces exposed to ocean waters (fig. 3). This biological interdiction interferes with the performance and service life on fixed and mobile surface and underwater structures. Very few known materials remain free from fouling immersed in the sea. The total number of known species of marine plants and animals involved in fouling problems was estimated in 1950 to exceed 2,000 and is now estimated at 4,000 to 5,000. However, the list of dominant fouling species is relatively small.

While most fouling organisms can exist and grow over a wide range of salinities, they generally require special conditions for attachment and early development to occur. Although barnacles can attach to objects at current speeds up to 4 kn, many organisms require minimal or no water movement at the crucial period of settlement. However, once attached, many fouling forms can maintain attachment at water speeds in excess of 12 kn.

Fouling creatures are generally categorized as hard bodied or soft bodied. All fouling creatures go through a soft-bodied stage prior to attachment. Algae and sponges retain this soft-bodied characteristic, while barnacles, mollusks, tubeworms, and many others develop hard coverings (usually calcareous) following attachment (fig. 4). Microorganisms play

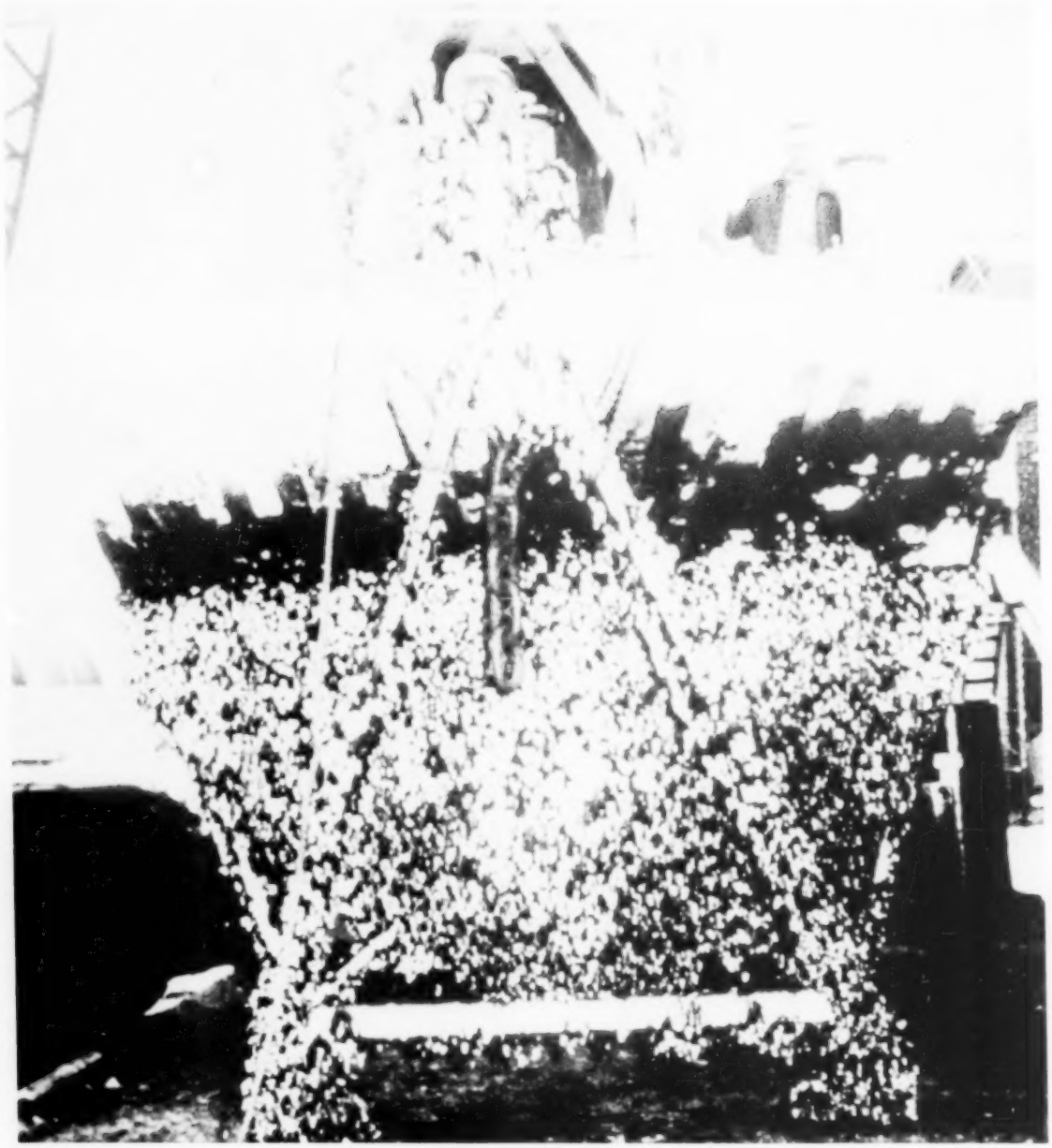

Figure 3. --A spectacular display of fouling appeared when this NOMAD buoy was lifted free of the water.

a major role in fouling in that they can break down surface coatings, thereby increasing vulnerability to attachment secretions of free-floating potential foulers.

There are generally three stages of development of fouling communities accompanied, as would be expected, by increasing frictional resistance to currents or movement with respect to water until a stable or quasi-dynamic (for a moving platform) stage is reached. These stages are:

- Slime--a mucoidal layer of unicellular microscopic organisms consisting of algae, bacteria, diatoms, and protozoa which produces an incipient stage often invisible but detectable by touch. This slime frequently retards toxic releases of antifouling compounds, thereby encouraging the growth of more seri-

Figure 4.--These barnacles look like tulips, but their beauty hides trouble. Photo courtesy of Todd Shipyards Corporation.

ous foulers. Slime growth can generally be removed by light scrubbing.

- Noncalcareous fouling of multicellular organisms, largely algae, hydroids, tunicates, and bryozoa, is usually the first visible stage of fouling. In its early form this fouling resembles grass, and it can generally be removed by brushing in the presence of sea water without appreciable damage to the paint surface.

- Calcareous fouling, which includes barnacles, tubeworms, encrusting bryozoa, and oysters, is usually present in increasing amounts along with the noncalcareous forms as the effectiveness of antifouling paint diminishes. Removal of calcareous fouling is tough and time consuming and usually damages paint surfaces. In advanced stages of growth, it also affects anticorrosive coatings.

FACTORS AFFECTING TYPE AND RATES OF FOULING

The following factors affect the type and rate of fouling:

Temperature	Nutrients	Depth
Salinity	Light	Geographic location
Oxygen	Currents (or movement with respect to water)	Land masses

TEMPORAL AND SPATIAL DISTRIBUTION

In general, waters with a mean temperature colder than 15°C experience accelerated fouling in spring and the warmer months and slow fouling throughout the remainder of the year--particularly in winter. In waters with a mean temperature of 15°C or warmer, growth of some form, particularly barnacles and oysters, is rapid throughout the year. The colder waters are also generally characterized by the existence of fouling in two layers--kelps and mussels from the surface to depths of as much as 100 ft and barnacles and oysters along the bottom. The most abundant and varied growth occurs in the upper layer of the ocean through which sunlight can penetrate in sufficient quantity to permit plant growth. This plant growth sustains very small invertebrate herbivores, which in turn are food for larger animals.

Because of an abundance of nutrients from land, coastal waters are generally the broodsites of larvae which are frequently carried to offshore substrates by coastal currents. Therefore, fouling decreases in intensity with depth and with distance from shore. However, with gentle offshore slopes, tidal influences extend over greater distances seaward, and the related seaward decrease in larvae concentrations and fouling is slower. Conversely, larvae concentration and fouling in the vicinity of coral reefs increase more rapidly seaward, possibly from grazing by reef fish. Harbors and estuaries are subject to extremely vari-

able fouling in response to pollution and local factors. Here tunicates and soft forms are common; tubeworms replace barnacles as a dominant form where pollution is high.

Open sea fouling diminishes from the surface to the bottom of the mixed layer and is generally insignificant below the mixed layer except near the bottom at all depths. Different water masses generally have different dominant fouling species; however, growth weights in warm water coastal environments do not vary greatly from one water mass to another.

PREDICTION OF FOULING

Most of the information on fouling is based upon long-term collections of fouling creatures on various materials under a variety of conditions. A summary of the major testing stations throughout the world was recently prepared under the direction of Romanovsky of the French Center of Oceanographic Studies and Research. Information collected at some of these testing stations and from a large number of independent collections has been summarized in a Naval Oceanographic Office Informal Report, "World Atlas of Coastal Biological Fouling, Part I, North America, South America, Iceland and Greenland." This atlas lists the major fouling forms and the months of maximum attachment based on collections from over 225 testing stations. It also includes charts giving estimates of fouling severity for all coastal areas. Based on the collection experiences of the fouling community and a long-term collection program by the U.S. Naval Oceanographic Office, DePalma recently prepared forecast procedures and nomograms to assist in the preparation of warm-water coastal fouling rates. He estimates a 70-percent reliability in his predictions.

To predict warm-water (fig. 5) coastal fouling rates using DePalma's method: (1) If the bottom slope is at least 2°, estimate the depth of water, distance from shore, and the anticipated length of exposure; (2) plot depth and distance from shore on Basic Warm-Water Coastal Fouling Rate Zone Chart (fig. 6); (3) from this chart, determine the zone and the relative position (low, medium, or high) within the zone; and, finally, (4) plot this relative position within a specific zone versus the anticipated total months of exposure on the Warm-Water Coastal Fouling Scattergram (fig. 7). The resulting figure is an estimate of the dry weight of fouling in grams per one-half square ft.

EFFECTS ON SHIPS AND OFFSHORE STRUCTURES

Biological growth occurs on any object which is immersed in the sea. The composition or treatment of the object may retard or modify the growth or result in selective attachment; however, all materials are affected in some way. The following is a brief list of common fouling effects:

- Impairment of operations
- Destruction of hardware
- Change in hydrodynamic characteristics
- Alteration of heat transfer characteristics
- Alteration of buoyancy characteristics
- Increase in water noise
- Reduction of effectiveness of underwater sensors
- Damage to corrosion-protective coatings
- Acceleration of corrosion
- Effects on mooring lines
- Reduction of flow or choking of seawater piping systems

The fouling effects most obvious to the ship operator are the reduction of speed and increase in fuel

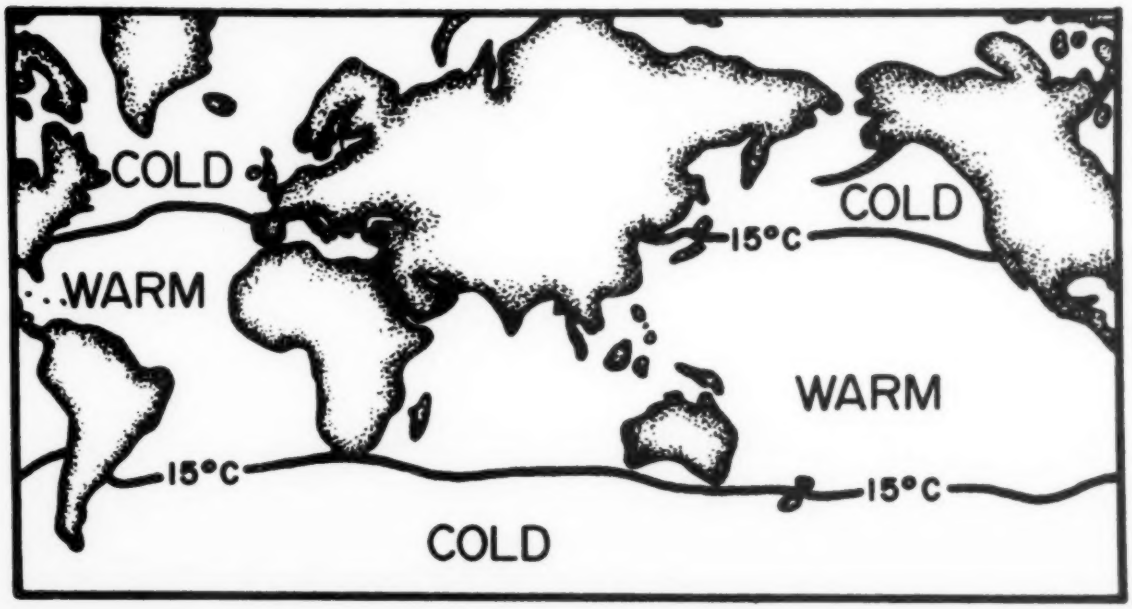

Figure 5. --Generally accepted limits of warm seas (DePalma).

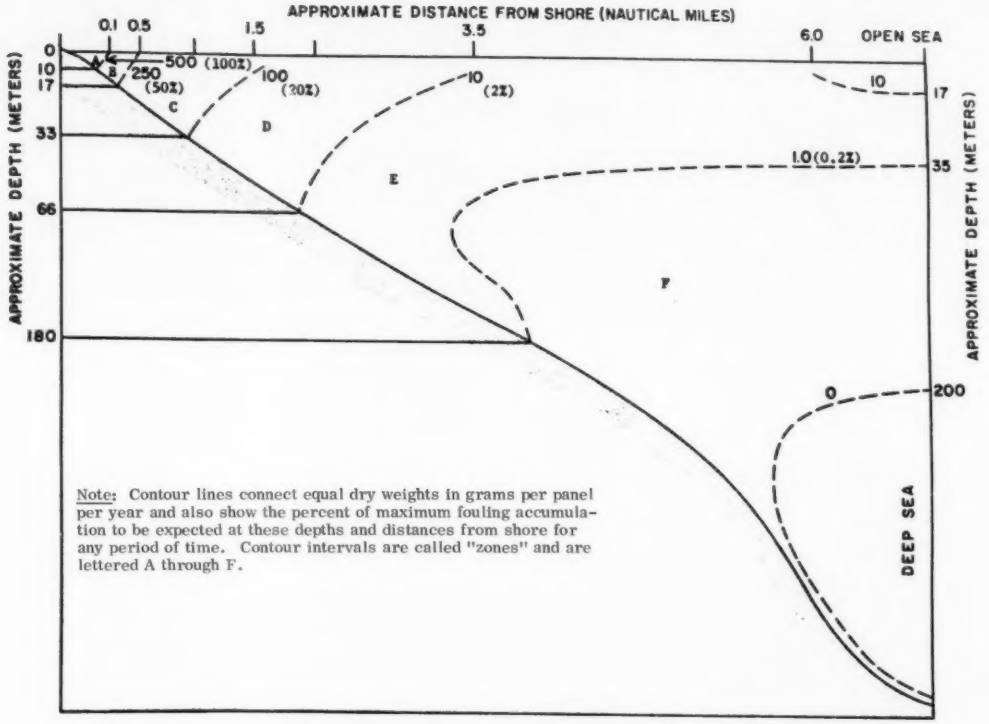

Figure 6.--Basic Warm-Water Coastal Fouling Rate Zone Chart (DePalma).

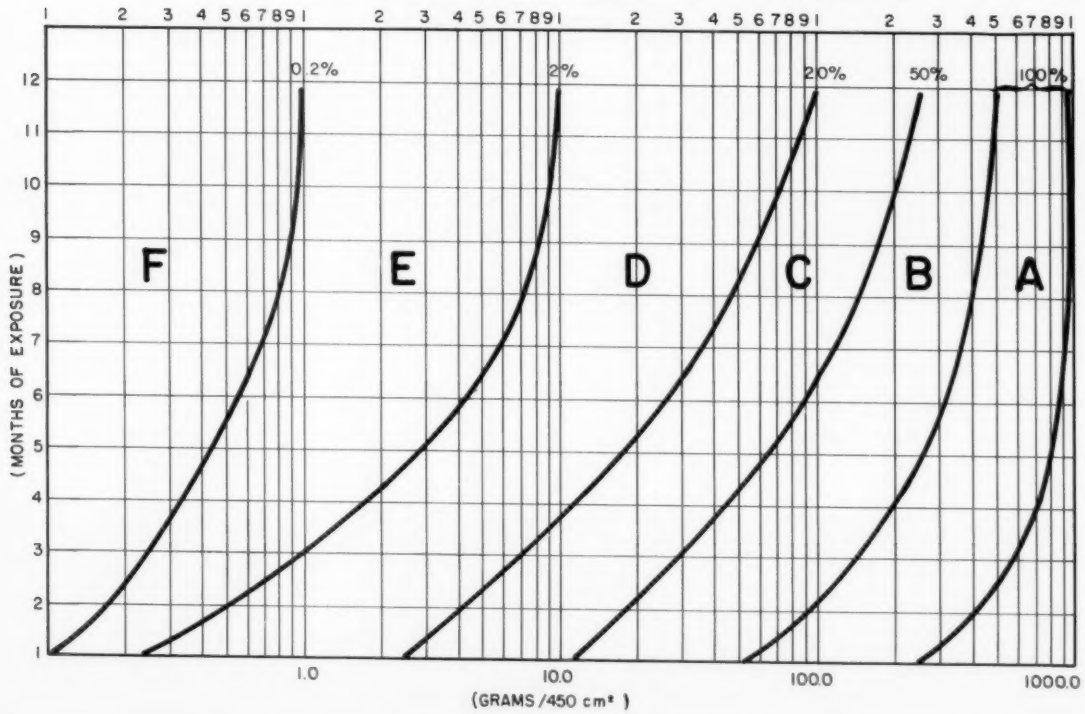

Figure 7.--Warm-Water Coastal Fouling Rate Scattergram (DePalma).

consumption, both of which result from increased frictional resistance. Increases in fuel consumption of 30 percent or more have been reported as a result of fouling. As an illustration of the economics of retaining high performance characteristics, Van Londen, in an article prepared for the 3d International Congress on Marine Corrosion and Fouling, pointed out that a 1-percent increase in speed of a 250,000 DWT tanker could result in an annual savings of $90,000. A recent U.S. Navy study initiated in the interest of conserving energy estimated the increased fuel costs due to fouling resistance at $20 million for the destroyer fleet alone. Additional benefits would also be derived from the prolongation of the effectiveness of antifouling paints. Most mobile platforms (ships) are treated externally with antifouling materials which release poison during aging. Acceleration of this release usually occurs with increased speed and turbulence; however, the attachment of foulers is also increasingly inhibited with increased ship speed. Therefore, fouling can be appreciably reduced when ships keep moving and spend as little time as possible in port and in coastal environs. Conversely, fixed structures, slow-moving coastal vessels, and fishing vessels, which usually operate at varying speeds in areas of high biological productivity, are susceptible to rapid accumulations of fouling.

Although there have been numerous test sites throughout the world for the collection of fouling information, the number and representativeness of these sites have usually been inadequate. Large changes in fouling communities can occur over small distances in response to the complex interplay of environmental and pollution parameters. Near-shore and shallow-water structures are particularly susceptible because of their proximity to food and nutrient sources, the prolific bottom dwelling communities in these waters, and the generally weak water currents, which seldom inhibit attachment. Each of these structures, in turn, serves as a new fouling community. A recent study of problems relating to North Sea oil platforms concluded that the effect of marine growth drag has not been fully evaluated and that marine growth is more rapid and penetrates to greater depths than expected.

MARINE FOULING RESEARCH

DePalma, in an assessment of marine fouling research prior to 1964, cites the following as the most serious shortcomings in fouling surveys:

Insufficient areal coverage
Sites not representative
Measurements not uniform
Investigations mostly short term
Environmental data lacking
Quantitative information on effects of fouling limited

Although an increasing number of investigations have taken place in recent years, these same problems exist today with only general methods available for prediction purposes. A great deal of work, however, is directed towards materials and protective coatings. Recent tests of a copper-nickel hull on a shrimp trawler proved so successful (3-1/2 yr barnacle free in tropical waters) that a fleet of these vessels is now planned. Certain biologically-active, polymetric coating materials have exhibited 100 percent antifouling effectiveness after a 2-1/2 yr exposure in a severe fouling climate. Studies also have been undertaken in the use of high-velocity water, microorganisms, and pollutants to inhibit attachment and growth. Microorganism films have been studied to determine their role in fouling, while attachment and growth are being studied in order to come up with fouling controls.

In summary, however, it appears that the magnitude of the fouling problem--the cost of preservation of materials in the seawater environment--is seriously out of proportion with current research efforts.

WE OF NOAA ARE MAKING USE OF THIS SMALL AMOUNT OF SPACE TO EXTEND OUR THANKS TO ALL THE SHIPS' OFFICERS WHO ROUTINELY TAKE SHIPBOARD WEATHER OBSERVATIONS. TO US THESE EXCELLENT OBSERVATIONS ARE PRICELESS. WE CERTAINLY DO APPRECIATE RECEIVING THEM ON A REGULAR BASIS.

ARCTIC ALASKA NORTH SLOPE RESUPPLY OPERATIONS

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The Alaska Arctic coast is a unique challenge to the mariner. Resupply operations by sea to Indian villages, military installations, and, in recent years, the Prudhoe Bay oil fields along the Arctic coast present a cargo scheduling problem unlike that found in any other U.S. waters. The navigation season is highly variable in length and in date of opening. In 24 yr of records, the earliest opening date was July 19, and the latest was September 13. The worst navigation season on record occurred in 1975 when the largest commercial resupply operation ever mounted in the Alaska Arctic departed Seattle in early July for the Prudhoe Bay oil fields, 180 mi east of Point Barrow (fig. 8).

The flotilla consisted of 23 tugs and 47 barges under control of Arctic Marine Freighters, a Crowley Maritime Corporation subsidiary under contract to Atlantic Richfield Oil Company and British Petroleum. Much of the $500 million cargo consisted of seven-story prefabricated buildings and fuel storage tanks too large to be shipped by any other means. Tug and barge is the only practical means of transport in the very shallow coastal waters between the main polar icecap and the shore. The fleet arrived in the holding area, an unsheltered strip of coast 150 mi southwest of Point Barrow, during the third week of July 1975 to await the opening of the navigation season. This was the traditional method of scheduling to ensure that the

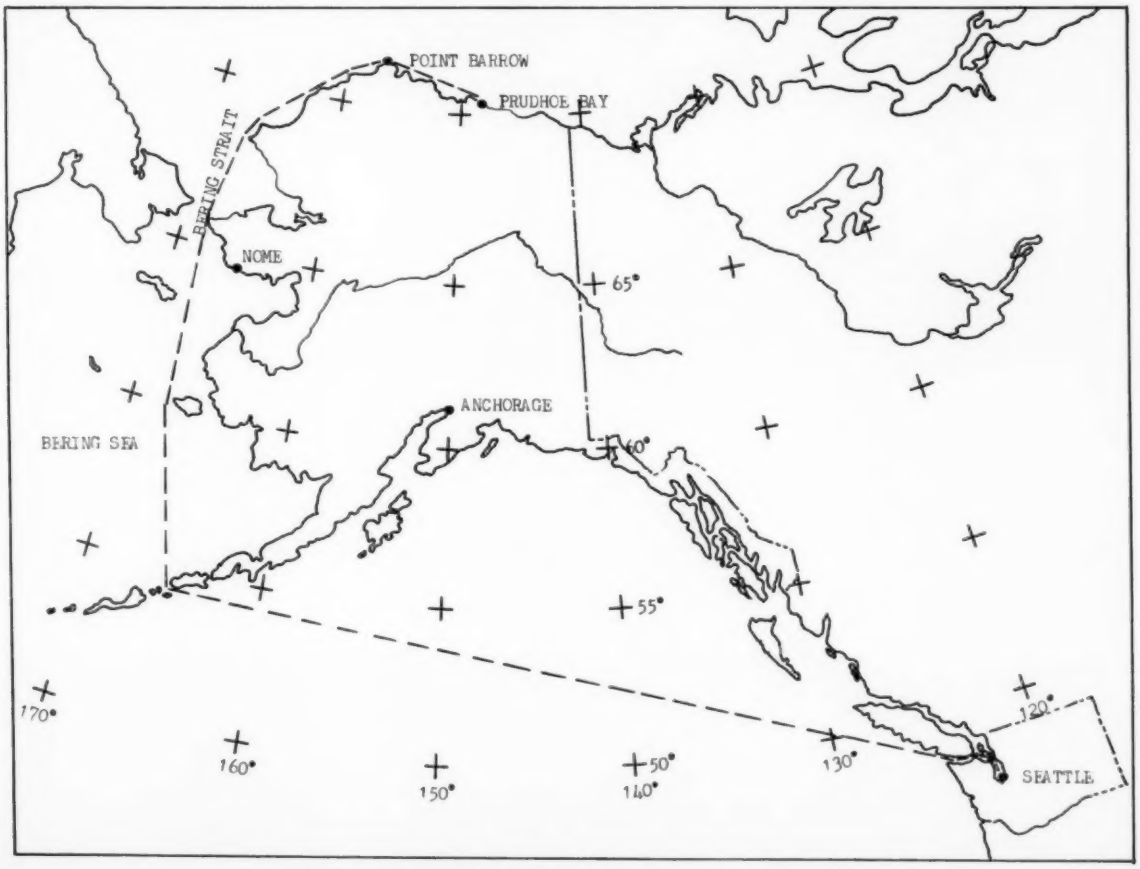

Figure 8.--Resupply trackline from Seattle to Prudhoe Bay.

Figure 9. --Tug (stern, far right) with barge in tow following in path cleared by other tugboats in 11 ft thick ice. Photo courtesy of Arctic Marine Freighters.

fleet would be able to make the run between Point Barrow and Prudhoe Bay at the earliest possible date. Everything appeared okay. It was expected that the first-year sea ice between the shore and the polar icecap would gradually melt and shift away from shore, permitting transit to Prudhoe Bay. Such was not the case.

Weeks went by, and the ice did not budge. The fleet was left exposed to storms moving northward along a storm track from southern Bering Sea through the Bering Strait. The constant motion of the barges frayed the towing cables, which were dragging across the shallow sea bottom. There were no sheltered anchorages to wait in. Gales in late July and early August forced two of the barges aground, but fortunately the bottom was sandy, and only minor damage was suffered. Extensive narrow leads in the ice enabled 10 barges to reach Prudhoe Bay during September 4-7. Fifteen more barges made it to Prudhoe Bay on September 26. The transit by this last group required considerable icebreaking efforts by the U.S. Coast Guard (fig. 9). The rest of the cargo was returned to various Alaska ports for shipment overland where feasible or delayed until the 1976 sealift, both involving heavy additional costs. Costs of the extended standby time, transhipments, and other measures were $75 million.

The 1976 fleet (about half the size of 1975) departed Seattle during the first week of July to arrive at the holding area during the third week as usual. Once again, the route was not open to Prudhoe Bay. Predictions made by the Navy 3 mo in advance had indicated that the season would be late opening but would be less severe than in 1975. However, in 1976 the ARCTIC CHALLENGER (fig. 10), a specially designed icebreaking barge powered by two 9,000 hp tugs pushing it from the stern, was standing by to assist the fleet. In its operational trials, the ARCTIC CHALLENGER succeeded on about August 13 in opening a pathway through the sea ice just east of Point Barrow to allow the first units of the fleet to continue on to Prudhoe Bay on August 14. On the 15th, the navigation season opened naturally, permitting easy transit all the way from Point Barrow to the oil fields.

Expensive premature arrivals at the pack ice boundary and use of icebreaking vessels can be minimized through the use of long-range seasonal predictions. Reliable predictions of the navigation season up to now have only been possible in the 30- to 90-day range. A unique numerical method for predicting the opening date and severity of the season 6 mo in advance has been developed by the authors. It is no longer necessary to rely exclusively on the traditional scheduling method which entails possible lengthy exposure to storms along the unprotected Alaska coast southwest of Point Barrow.

In a normal year, the first-year sea ice located between the main polar pack and the shore gradually

Figure 10.--Icebreaking barge, ARCTIC CHALLENGER, plowing through sea ice near Point Barrow, Alaska. U.S. Coast Guard Photo courtesy of Arctic Marine Freighters.

melts and is shifted about by winds and weak ocean currents. Prudent navigation without icebreaker assistance can be accomplished when first-year sea ice concentration is about four oktas--that is, half open water and half ice. The numerical model predicts when four oktas concentration will occur.

Operational requirements determine the acceptability of predictions as there is normally some variation between predicted and observed opening date. The computer model has not failed to provide sufficient turnaround time at Prudhoe Bay to enable all cargo to be offloaded. In other words, it gives an opening date so that at least a minimum, but sufficient, turnaround time (about 3 weeks) is always available. Of course, sea conditions enroute from Seattle to Point Barrow also must be considered to enable the fleet to arrive on the predicted opening date. The effectiveness of the model can be evaluated by comparing it with the other two long-range planning methods available. In order of decreasing delay time, they are the traditional method and the average method.

The traditional method in which shipments depart Seattle to arrive at the holding area southwest of Point Barrow about the third week of July has already been discussed. Part of the rationale behind this approach is to provide contingency time for unexpected mechanical breakdowns or delay due to adverse weather. However, this method results in very long waiting periods in seasons that open late and subjects the fleet to lengthy storm exposure in the holding area. Delays of over 6 weeks have been experienced. A refinement to this scheduling technique is the average method.

The average method, in the absence of any predictive skill, can reduce the waiting time in half compared to the traditional method. The average opening date of the navigation season is August 7. On the basis of data commencing in 1953, it can be shown that any season that opens after August 6 is classed as severe and may pose turnaround problems. Thus, any vessels arriving on that date and finding the way closed will experience shorter delays than if the traditional method of scheduling had been used. Seasons beginning before the average date have been long enough to make earlier arrival unnecessary. On the basis of historical data, the average opening date method is considerably more cost effective than the traditional method. However, the computer model developed by the authors reduces the average waiting time at the ice barrier almost in half again or to about one-fourth of the wait associated with the traditional method. Table 1 demonstrates this for the period 1969-76, during which tug and barge traffic to Prudhoe Bay became significant.

The actual results obtained for opening and closing

Table 1.--Days of delay in transit to Prudhoe Bay by scheduling technique, 1969-1976

Year	Traditional	Average	Model
1969	43	31	30
1970	12	0	1
1971	29	16	3
1972	6	0	0
1973	6	0	0
1974	12	0	6
1975	41	28	0
1976	21	8	0
Total	170	83	40

Table 2.--Opening dates, 1965-1976

Year	Recorded date	Predicted date
1965	August 25	August 28
1966	August 1	August 9
1967	July 25	August 1
1968	July 19	July 30
1969	September 6	August 8
1970	August 6	August 5
1971	August 23	August 20
1972	July 31	August 11
1973	July 31	July 31
1974	August 6	July 31
1975	September 4	September 4
1976	August 15	August 25

Table 3.--Closing dates, 1965-1976

Year	Recorded date	Predicted date
1965	September 25	October 5
1966	October 22	October 16
1967	October 12	October 2
1968	October 18	October 7
1969	September 18	September 28
1970	September 14	September 13
1971	November 1	October 20
1972	October 1	October 6
1973	October 20	October 15
1974	October 5	October 23
1975	October 7	October 8
1976	October 7	October 20

dates for 1965-76 are shown in tables 2 and 3, respectively. The opening dates were predicted 6 mo in advance as a test of the model's predictive capability. Closing date predictions were made 3 mo in advance.

The model is also capable of deriving a seasonal severity index 6 mo in advance that has proven very reliable (table 4). In its present experimental form, the severity index has a scale of 0 to 7 in which 0 indicates an exceptionally severe season and 7 an exceptionally mild one. As can be seen, a below-average

Table 4.--Index of potential seasonal severity, 1965-1976

Year	Navigation days	Severity index
1965	32	1.5
1966	65	4.6
1967	68	4.9
1968	91	5.5
1969	12	3.3
1970	32	1.7
1971	71	3.0
1972	63	3.5
1973	82	6.0
1974	61	6.3
1975	0	0.2
1976	53	1.1

index consistently indicates an unfavorable season. Navigation seasons of 32 days or less--the shortest and most severe seasons--have severity indices below average (e.g., 0.2, 1.5, 1.7, 3.3). This index value is valuable, not only in a qualitative sense but also because severe seasons in which unescorted navigation is feasible for fewer than 50 days begin on or after the historical average opening date. The index thus gives an independent check on the opening date prediction.

The results of computer model predictions compared to observed seasons are summarized in graphical form in figure 11. The closer the unshaded bar matches that of the adjoining solid bar, the more accurate the prediction.

Results obtained from this model indicate its superiority to both the traditional and average methods of scheduling North Slope resupply operations. Using the model in North Slope marine operation scheduling would:

- Significantly reduce shipment transit time from departure points to delivery along the Arctic coast;
- Reduce storm exposure risks to the resupply fleet along the unprotected northwest Alaska coast;
- Permit 6-mo advance planning for alternative delivery methods and/or additional icebreaker assistance for exceptionally severe seasons; and
- Permit long-range planning for a variety of ship operations along the Arctic coast, such as hydrographic surveying, geophysical exploration, and other operations requiring navigable waters.

It should be emphasized that the application of the model is only for long-range planning and not for tactical day-to-day operations during the navigation season. This still requires aerial observations, experienced ice interpretation, and short-range dynamical model predictions. The development of the authors' model has been achieved using a data base of minimum size (10 to 12 yr). With an expanded data base, further analysis of seasonal conditions, and appropriate refinements of the model, accuracy of the predictions will be increased still further; and the somewhat disappointing results observed for 1969 will be improved considerably. The model can be applied with ease by updating and processing the file of daily synoptic data relevant to the ensuing navigation season. For ex-

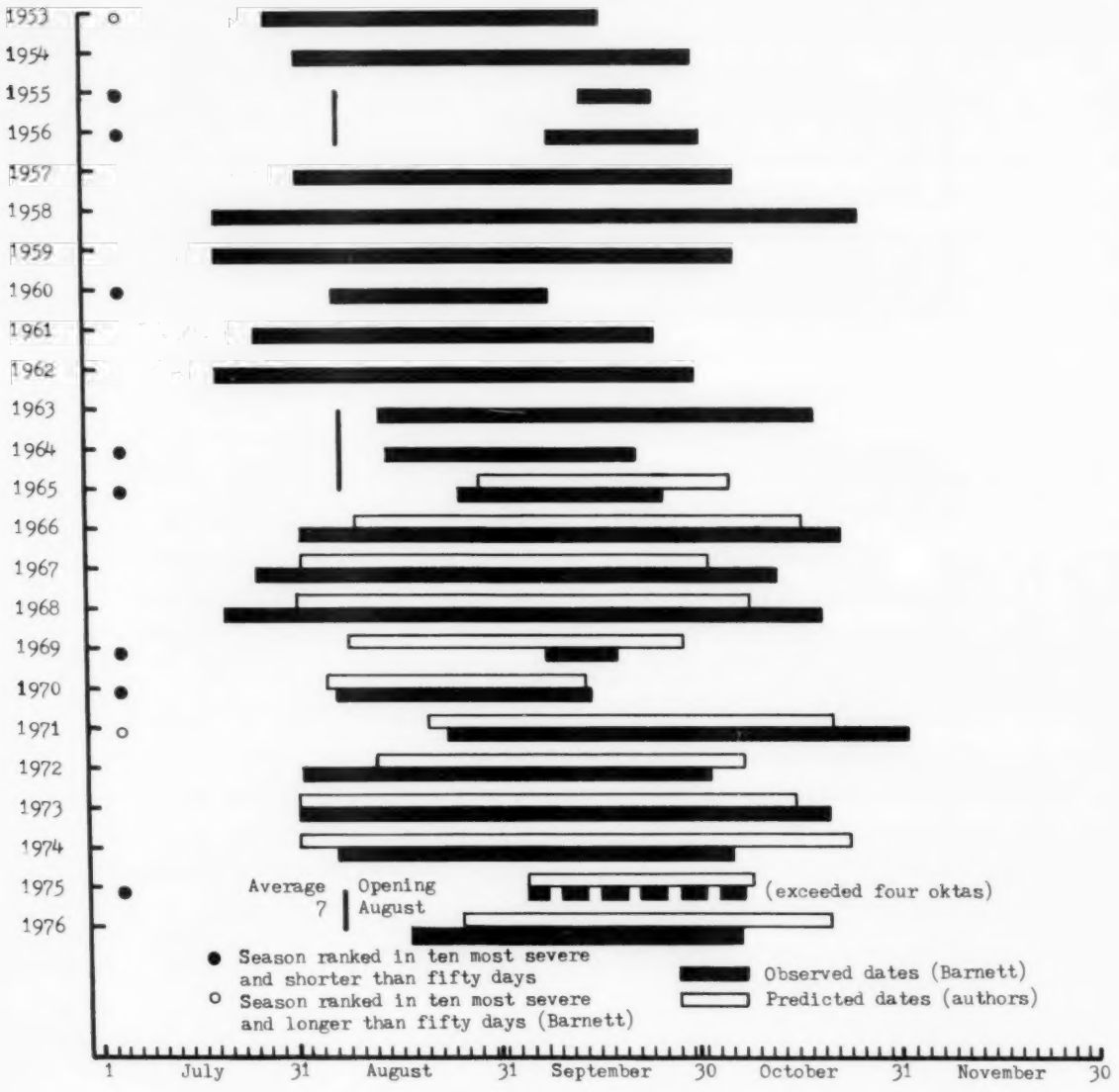

Figure 11.--Navigation seasons, north coast of Alaska (1953-1976).

ample, using data to the end of January, a prediction of the opening date, severity, and duration of the season can be made as early as the first week of February.

For additional details on the model and its application, write to Dr. John Stewart, P.O. Box 30753, Seattle, WA 98103.

ACKNOWLEDGEMENT

The authors would like to make special note of the work of D.G. Barnett of the Navy Fleet Weather Ice Facility, Suitland, Md., for his detailed analyses of past navigation seasons along the North Slope. Without his findings, the development of this model would have been much delayed.

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Britton, G.P., "The North Slope Resupply Operation in 1975," Annex G2 in Improvement of Marine Advisories and Optimum Track Ship Routing--a report to the U.S. Maritime Administration by the Sea Use Foundation, Seattle, Wash., March 1976.

Mariners Weather Log

WIND AND WAVE STATISTICS FOR THE NORTH AMERICAN, ATLANTIC AND GULF COASTS.

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and
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Asheville, N.C.

Since "Extreme Wind and Wave Return Periods for the U.S. Coast" was published (Mariners Weather Log, 19(2), March 1975), a new set of tables has been published by the U.S. Naval Weather Service Command under the title "Summary of Synoptic Meteorological Observations, North American Coastal Marine Areas - Revised, Atlantic and Gulf Coasts," May 1975. Although the areas (fig. 12) are not exactly the same as those used in the above-mentioned extremes article, they are quite similar along the U.S. coast. It is felt that some of the more generalized statistics would be of interest to the maritime community; therefore, tables of monthly and annual scalar mean windspeed and prevailing direction (table 5) and annual percent frequencies for various wave height categories (table 6) have been prepared.

Scalar mean wind is the average of all speeds (including calms) regardless of direction. The prevailing direction is the one most often reported. If two directions are reported in equal numbers and both qualify as most often reported, then both are considered prevailing.

Wave heights were computed using the higher of sea or swell when both were reported. Values are shown only in half meters, which is the degree of accuracy of the reporting code. Average wave heights could have been presented in somewhat more detail, but since the original summaries were presented in

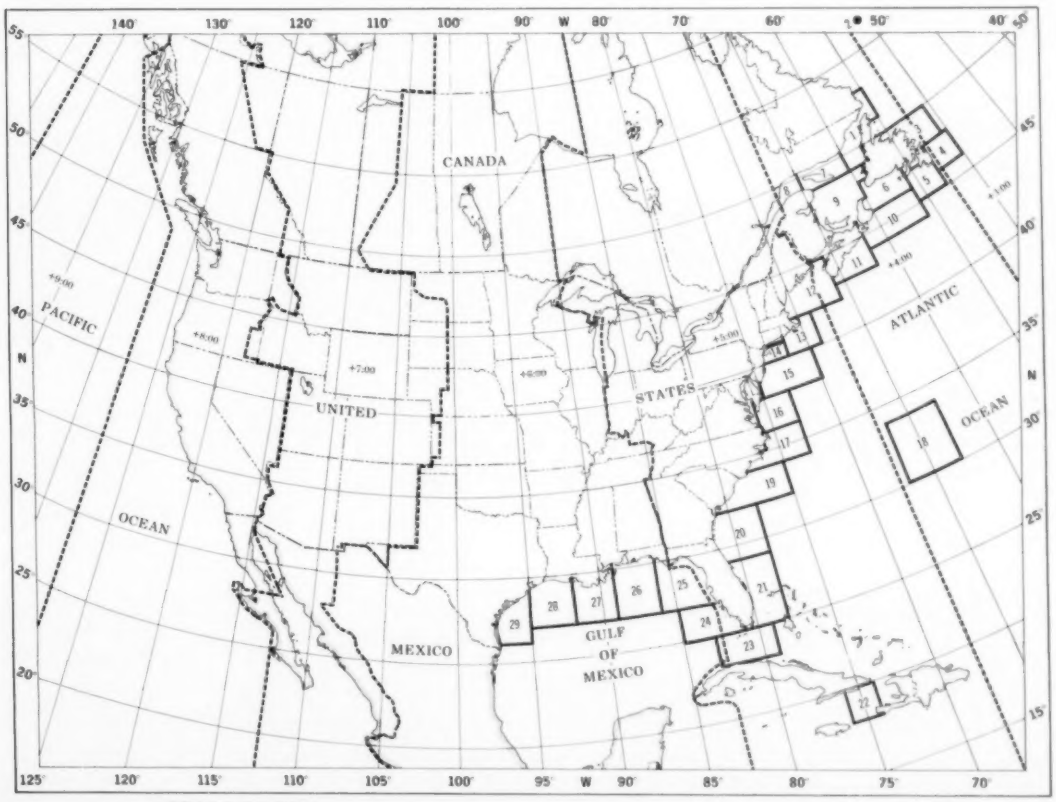

Figure 12.--North American coastal marine SSMO areas and standard time zones.

whole feet, conversion to metric units in more detail than half meters would not have been appropriate.

The data were obtained from marine surface observations taken by cooperating ships in passage. Such ships tend to avoid bad weather when possible, thus biasing the data toward good weather. All observations regardless of position in the area were summarized for that total area. The period of record varies according to location and element observed.

Table 5.--Monthly and annual scalar mean windspeed (kn) and prevailing direction (8 points)

AREA NUMBER	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		ANN		TOTAL OBS
	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	
1	19.5	NW	20.6	SW	20.1	NW	16.6	N	11.6	SW	12.0	SW	11.8	SW	11.8	SW	14.5	SW	15.9	SW	16.3	SW	16.0	NW	15.5	SW	13,203
2	24.4	W	23.7	NW	22.2	NW	19.7	N	16.7	NW	15.6	NW	13.9	S	15.0	S	18.8	NW	21.6	NW	21.9	W	23.6	NW	19.8	NW	69,046
3	18.7	W	18.2	W	15.7	SW	15.0	N	13.5	N/S	13.4	S	12.9	S	13.6	S	14.7	SW	17.2	SW	18.3	NW	19.8	W	15.9	SW	9,842
4	19.9	W	21.0	W	18.4	W	16.0	SW	13.5	SW	12.2	SW	12.0	SW	12.7	SW	14.2	SW	16.5	W	17.6	W	19.6	W	16.1	SW	29,978
5	20.2	W	20.8	W	19.1	W	16.2	W	13.2	W	12.1	SW	11.0	SW	11.6	SW	13.3	W	16.0	W	17.6	W	19.3	W	15.9	W	33,079
6	20.3	W	20.6	W	17.9	W	15.5	NW	12.2	W	11.3	S	10.9	SW	12.7	SW	15.0	W	16.3	W	18.4	W	19.3	W	15.9	W	18,043
7	21.6	NW	20.2	W	16.8	W	14.3	NW	12.5	NW	11.4	W	10.6	W	10.9	W	12.6	W	15.2	W	16.8	W	18.7	NW	15.1	W	7,646
8	17.6	W	18.7	W	17.5	W	13.7	NE	12.5	NE	12.2	SW	11.7	SW	11.7	SW	12.4	SW	14.3	W	15.3	W	16.8	W	14.5	W	13,776
9	19.3	W	20.4	W	18.7	N	14.3	NW	12.0	NW	11.6	S	11.6	SW	12.2	SW	14.3	SW	16.2	NW	17.8	NW	19.9	NW	15.7	NW	18,341
10	20.1	W	19.8	W	18.4	W	15.7	W	13.3	SW	12.0	SW	10.5	SW	11.9	SW	13.7	SW	16.4	W	17.4	W	20.0	W	15.8	W	50,935
11	18.5	NW	17.6	W	16.6	W	13.9	SW	12.4	SW	11.2	SW	10.2	SW	11.2	SW	12.5	SW	14.6	W	16.1	W	18.5	W	14.4	SW	40,275
12	18.7	NW	18.2	NW	16.5	NW	14.0	SW	12.0	SW	11.1	SW	10.1	SW	10.0	SW	11.2	SW	13.5	SW	16.2	NW	19.2	NW	14.2	SW	70,448
13	17.0	NW	16.2	NW	15.2	W	12.8	W	10.6	SW	9.9	SW	8.9	SW	9.6	SW	11.1	SW	13.1	W	15.1	W	17.2	NW	13.1	W	101,776
14	15.1	NW	15.0	NW	13.4	NW	12.5	W	10.3	SW	9.7	S	8.9	S	9.2	SW	10.7	SW	12.2	NW	14.4	W	15.4	W/NW	12.2	SW	35,557
15	16.9	NW	16.7	NW	15.0	NW	13.2	SW	11.2	SW	10.4	SW	10.3	SW	10.9	SW	12.0	NE	14.1	NE	15.6	NW	16.6	NW	13.6	SW	123,311
16	16.3	N	16.0	N/NW	15.3	N	13.8	S/SW	11.7	S	10.9	S	10.8	SW	10.9	SW	12.2	NE	13.8	N/NE	14.9	N	15.6	NW	13.5	N	141,578
17	17.8	N	18.3	N	17.3	N	15.8	SW	13.7	SW	12.3	SW	12.0	SW	11.7	SW	12.8	NE	15.3	NE	15.8	N	16.5	N	14.9	N	129,564
18	15.1	W	16.1	W	15.5	W	13.4	SW	10.7	S	9.9	SW	9.4	SW	9.1	SW	10.9	E	12.4	NE	14.0	NE	15.5	NW	12.7	SW	56,590
19	16.8	N	17.6	N	16.8	W	15.1	SW	13.4	SW	12.4	SW	12.1	SW	11.8	SW	13.3	NE	15.5	NE	15.6	N	16.2	N	14.7	SW	139,754
20	15.5	NW	15.9	NW	15.2	NW	13.9	E	11.7	E	11.1	S	10.2	SW	10.3	E	12.7	NE	15.0	NE	14.8	NE	14.6	W	13.4	NE	133,136
21	13.6	E	13.6	E	13.1	E	12.3	E	10.6	E	9.4	E	8.8	E	8.9	E	10.8	E	12.9	NE	13.5	NE	13.4	E	11.7	E	148,576
22	12.1	NE	11.1	NE	11.3	NE	11.1	NE	10.1	E	9.7	E	10.7	E	9.8	E	8.9	E	9.0	E	11.5	NE	12.1	NE	10.6	NE	54,284
23	12.7	E	12.4	E	12.1	E	11.8	E	10.2	E	9.1	E	9.1	E	8.7	E	10.0	E	11.9	E	13.1	E	12.9	E	11.2	E	103,001
24	12.8	E	12.6	E	12.4	SE	11.7	E	10.0	E	8.6	E	9.1	E	8.0	E	10.3	E	12.2	NE	12.7	NE	12.6	E	11.0	E	58,487
25	12.2	N	13.6	E	11.7	SE	11.0	SE	8.5	E	8.1	E	7.6	SE	8.0	E	11.5	E	11.9	E	13.0	NE	12.7	E	10.8	E	9,318
26	13.9	N	13.9	SE	13.3	SE	12.1	SE	10.1	SE	8.9	SE	8.3	SE	8.5	E	11.7	E	12.8	E	13.2	E	13.3	E	11.7	E	82,661
27	13.9	N	13.9	SE	13.6	SE	12.5	SE	10.7	SE	9.1	SE	8.1	SE	8.5	SE	11.7	E	12.7	NE	13.5	E	13.8	E	11.8	E/SE	92,411
28	13.4	N	13.3	SE	12.7	SE	12.2	SE	11.1	SE	9.9	SE	8.8	S	8.6	SE	11.5	E	12.2	E	13.3	SE	13.6	N	11.7	SE	57,715
29	14.0	SE	13.8	SE	13.3	SE	13.2	SE	12.2	SE	12.1	SE	10.1	SE	9.9	SE	11.5	E	12.6	SE	14.5	SE	14.6	SE	12.6	SE	16,226

Table 6.--Annual percent frequency of wave heights in various categories

AREA NUMBER	Wave Heights (Meters) 0	½	1	1 ½	2	2 ½	3	3 ½	4 – 4 ½	5 – 5 ½	6 – 6 ½	7 – 7 ½	8 – 9 ½	10 – 12	12 ½ – 14 ½	≥ 15	TOTAL OBS	AVG HT (M)
1	13.2	18.5	24.1	16.4	11.8	6.0	3.4	2.3	3.0	.6	.6	*	.1	.0	.0	.0	5,184	1
2	.5	2.6	11.3	12.5	17.4	12.9	13.0	9.1	9.7	5.0	3.0	1.6	1.5	*	*	.0	65,857	2 ½
3	3.2	8.5	19.5	18.1	17.3	10.7	8.2	4.5	6.6	1.8	.9	.4	.2	*	.0	.0	3,890	2
4	3.3	9.5	20.6	19.5	16.8	10.3	7.5	4.3	5.3	1.3	.8	.4	.3	*	.0	.0	16,553	2
5	3.8	11.6	24.7	19.7	15.7	8.3	6.0	3.8	4.0	1.1	.8	.2	.3	*	.0	.0	18,231	2
6	5.9	14.8	25.5	17.8	13.2	7.1	5.4	3.3	4.2	1.2	.8	.3	.4	.1	.0	.0	7,022	1 ½
7	16.0	23.4	27.2	15.5	7.9	4.5	2.1	2.0	.7	.4	.3	.0	.0	.0	.0	.0	2,538	1
8	25.0	27.5	24.3	11.5	5.8	3.2	.8	1.3	.4	.1	.1	.0	.0	.0	.0	.0	2,736	1
9	11.6	17.8	26.1	17.9	11.9	5.8	3.5	1.7	2.3	.5	.2	.5	.1	*	.0	.0	5,830	1
10	5.0	12.6	23.1	19.3	14.8	8.8	6.2	3.9	4.0	1.0	.6	.3	.3	*	*	.0	27,707	2
11	5.0	14.5	26.2	20.6	14.7	7.5	4.9	2.6	2.7	.6	.5	.2	.1	*	*	.0	22,762	1 ½
12	14.5	25.2	26.4	13.9	9.1	4.5	2.9	1.5	1.3	.3	.2	.1	.1	*	.0	.0	35,979	1
13	12.1	23.3	27.2	15.7	8.9	4.7	3.3	1.6	2.1	.5	.4	.1	.1	*	*	.0	46,601	1
14	12.7	29.6	29.9	14.2	6.7	2.9	1.7	1.0	.8	.1	.2	.1	*	.0	.0	.0	10,206	1
15	9.3	21.7	27.5	17.8	9.7	5.8	3.3	1.8	2.0	.4	.4	.2	.1	*	*	.0	74,208	1
16	9.4	24.7	29.6	16.6	8.7	4.8	2.6	1.5	1.4	.2	.2	.1	.1	*	*	.0	87,271	1
17	6.1	17.6	27.3	21.0	12.0	7.2	3.8	2.2	2.1	.4	.3	.1	.1	*	*	.0	96,657	1 ½
18	6.1	15.4	25.7	19.3	13.3	7.6	4.6	2.8	3.0	.7	.6	.4	.4	*	*	.0	29,880	1 ½
19	5.5	17.0	27.4	22.2	12.1	7.4	3.5	2.2	1.9	.3	.3	.1	.1	*	.0	.0	114,443	1 ½
20	8.6	21.1	28.5	19.4	10.2	5.9	2.9	1.6	1.3	.2	.2	*	.1	*	.0	.0	104,775	1
21	12.7	26.2	29.1	17.1	7.5	3.9	1.7	.9	.8	.1	.1	*	*	*	.0	.0	110,244	1
22	17.2	29.1	29.5	14.8	6.1	2.0	.8	.3	.2	*	*	.0	.0	.0	.0	.0	32,156	1
23	16.8	32.2	29.3	13.6	5.0	1.8	.7	.3	.2	*	*	*	*	.0	.0	.0	73,335	1
24	14.3	27.1	30.2	16.7	6.6	2.9	1.1	.6	.4	.1	.1	*	.0	.0	.0	.0	45,065	1
25	17.9	27.3	27.9	14.8	6.3	2.9	1.4	.7	.7	.1	.0	.0	.0	.0	.0	.0	6,439	1
26	14.2	26.8	29.5	16.3	6.9	3.3	1.4	.8	.6	.1	.1	*	*	.0	.0	.0	59,374	1
27	14.2	25.6	29.7	17.3	7.1	3.4	1.3	.7	.6	.1	.1	*	*	.0	.0	.0	77,800	1
28	13.9	26.1	30.4	17.1	6.7	3.3	1.2	.6	.5	.1	.1	*	*	.0	.0	.0	47,507	1
29	8.3	24.2	33.3	18.3	8.2	4.2	1.7	.9	.7	.1	.1	*	.0	.0	.0	.0	13,371	1

* = less than .05% but greater than 0.

Hints to the Observer

NONUNIFORM VISIBILITY

Visibility frequently is not reduced around the horizon circle in a uniform manner. Fogbanks, showers, or haze may reduce visibility in only a portion of the circle. When only a part of the horizon is obscured, a simple rule for reporting visibility has been formulated: Report the greatest distance objects are visible over one-half or more of the horizon circle. This is the definition of prevailing visibility or visibility index.

Let us look at two examples. In figure 13, at the time of observation, a fog bank has drifted in from the northwest reducing visibility in one-half of the horizon circle to zero. The visibility observed in the other half of the circle is 4 mi. Since the observed visibility is within the range of 2 to less than 5 mi, Code Figure 96 under symbol VV on NOAA Form 72-1 (Ship's Weather Observations) is reported.

Figure 14 shows nonuniform visibility caused by various weather phenomena obscuring portions of the horizon. One quadrant of the horizon circle is relatively unobstructed with a visibility of 4 mi. In the southwest quadrant visibility is reduced to 3 mi by haze. Visibility is reduced by showers in the northern semicircle, with light showers in the northwest and moderate showers in the northeast. The observer can recognize objects at 2 mi to the northwest but only at 1 mi to the northeast. Since the visibility common to one-half or more of the horizon circle is 3 mi, this is the prevailing visibility. Code Figure 96 is reported in the coded weather message.

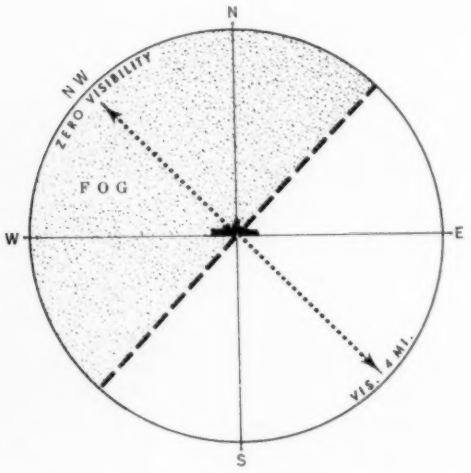

Figure 13.--Fog obscures one-half horizon circle.

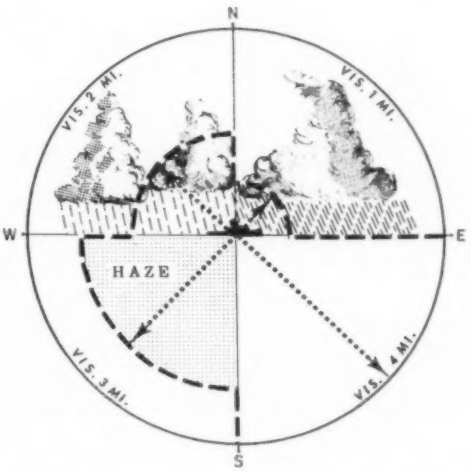

Figure 14.--Various weather phenomena obscuring horizon.

Tips to the Radio Officer

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CORRECTIONS TO PUBLICATION, WORLDWIDE MARINE WEATHER BROADCASTS, May 1976 Edition

Page 6--Grindstone, Quebec, Canada (VCN): Delete station.

Page 15--Rio de Janeiro, Brazil (PPR): Delete freq. 13105.5; insert 4244, 12687. Add time 1000 for warnings, analyses, and forecasts.

Page 24--Adelaide, Australia (VIA): Delete times 0948, 2208; insert 0018, 1018.
Melbourne, Australia (VIM): Delete freq. 6502; insert 6333.5. Delete times 0918, 2218; insert 0948, 2318.

Page 25--Thursday Is., Australia (VID): Delete freq. 6502; insert 6333.5. Delete time 0918; insert 0948.

Darwin, Australia (VID): Delete times 0100, 1318; insert 0048, 1048.
Rockhampton, Australia (VIR): Delete 6502, insert 6333.5.
Rabaul, New Britain (VJZ): Delete freq. 6519.5; insert 6351.5. Delete times 0100, 1240; insert 0000, 0900.
Port Moresby, Papua (VIG): Delete freq. 6519.5; insert 6351.5. Delete time 0030; insert 0048.

Page 29--Perth, Australia (VIP): Delete freq. 12993. Delete time 1300; insert 1200.

Page 36--Halifax, Nova Scotia (VCS): Add freq. 4431.8, 8770.4, 13154. Add times 0205, 0805, 1605, 2205.

Page 39--Nassau, Bahamas (VPN-2): Delete call sign VPN-Z, replace with C6N.
Fort de France, French Antilles (FFP): Add times 1333, 2333.

Page 44--Athens, Greece (SVA): Add freq. 8796. Add times 1215, 2015.

Page 51--Suva, Fiji Islands (3DP): Delete listed times; insert 0003, 0403, 0803, 2003.

Page 52--Darwin, Australia (VID): Add time 0348.
Melbourne, Australia (VIM): Delete listed times; insert 0733, 2148 Sun; 0718, 0733, 2148. Add note: Forecast for Bass Strait and Tasmanian waters, 1533.

Page 52--Port Moresby, Papua (VIG): Delete freq. 6405; insert 4407.
Rabaul, New Britain (VJZ): Delete freq. 6204; insert 4407.

Page 60--Misnamed station. Delete Cairo, Egypt; insert Nairobi, Kenya (5YE).

Page 71--Delete all of New York, NY (WSY70).

Page 77-78--Additions and corrections to listing of NOAA Weather Radio Stations:

Philadelphia, PA	KIH-28	162.475 MHz
Daytona Beach, FL	KIH-26	162.40 MHz
Key West, FL	KIH-25	162.40 MHz
Tallahassee, FL	KIH-24	162.40 MHz
Morgan City, LA	KIH-23	162.475 MHz
Gulfport, MS	KIH-21	162.40 MHz
Portland, OR	KIG-98	162.55 MHz
Brookings, OR	KIH-37	162.55 MHz
Newport, OR	KIH-33	162.55 MHz
Coos Bay, OR	KIH-32	162.40 MHz
San Luis Obispo, CA	KIH-31	162.55 MHz
Point Arena, CA	KIH-30	162.40 MHz
Neah Bay, WA	KIH-36	162.55 MHz

Hurricane Alley

Dick DeAngelis
Environmental Data Service, NOAA
Washington, D. C.

In the last column we mentioned that we would run excerpts from the Typhoon Havens Handbook for the Western Pacific and Indian Oceans by Samson Brand and Jack W. Bleiloch. We feel that the information contained in this handbook is so valuable to the mariner that it should be run as a series of articles. Look for these informative reports in future issues.

September and October, along with November, mark the height of North Indian Ocean tropical activity and the beginning of the Southern Hemisphere season. The northern waters were more active than normal during September and October with three storms, while one storm developed in the South Indian Ocean (fig. 15).

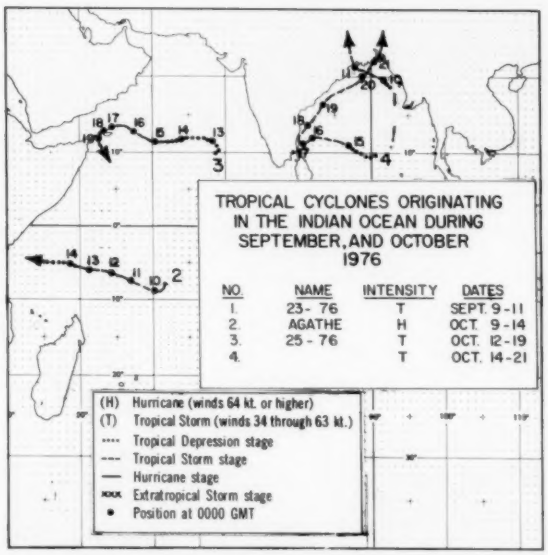
TROPICAL CYCLONES ORIGINATING IN THE INDIAN OCEAN DURING SEPTEMBER, AND OCTOBER 1976
NO. NAME INTENSITY DATES
1. 23-76 T SEPT. 9-11
2. AGATHE H OCT. 9-14
3. 25-76 T OCT. 12-19
4. T OCT. 14-21
(H) Hurricane (winds 64 kt. or higher)
(T) Tropical Storm (winds 34 through 63 kt.)
Tropical Depression stage
Tropical Storm stage
Hurricane stage
Extratropical Storm stage
Position at 0000 GMT

Figure 15.--Tracks of Indian Ocean tropical cyclones, September and October 1976.

NORTH INDIAN OCEAN
SEPTEMBER AND OCTOBER

One September and two October tropical cyclones sprang to life this season. The September storm developed some 200 mi south of Chittagong on the 9th. Moving northwestward, it remained at minimal tropical storm intensity until late on the 10th. Early the next day, winds near the center were estimated at 50 kn as the cyclone came ashore south of Calcutta. Reports from the state of Orissa indicate that as many as 100 fishermen may have been lost during this storm.

Twin cyclones developed in October--one in the Bay of Bengal and the other in the Arabian Sea. The Arabian Sea storm was spotted just west of the Laccadive Islands on the 12th, while the other one was sighted 2 days later just west of the Nicobar Islands. Both storms moved on a west-northwesterly course

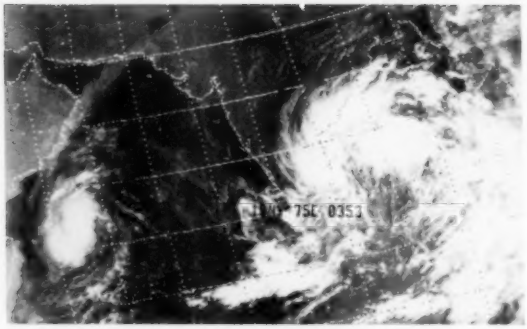

Figure 16.--Twin tropical cyclones, one in the Arabian Sea and the other in the Bay of Bengal, display their wares on October 16, 1976.

as they intensified (fig. 16).

The AMSTELLAAN ran into 35-kn winds in 10- to 15-ft swells on the 16th and 17th about 300 mi south of the Bay of Bengal storm's center. Winds near the center reached a peak of 40 to 45 kn. At about this same time, winds were reaching 50 kn in the Arabian Sea storm, which was approaching Socotra.

The Bay of Bengal system reached the southeast coast of India, turned northeastward, and paralleled the east coast until the 20th when she moved across the Mouths of the Ganges and into Pakistan. The Arabian Sea cyclone remained quasi-stationary and gradually weakened near Socotra.

SOUTH INDIAN OCEAN - OCTOBER

Agathe, the season's first tropical cyclone, formed on the 9th near 8°S, 61.5°E. Moving westward, she reached tropical storm strength the following day. Agathe peaked on the 11th. Winds near her center were estimated at about 60 kn. She continued westward but began to weaken. Agathe lost her identity before reaching the coast of Africa.

SOUTH INDIAN OCEAN TROPICAL CYCLONES, 1975-76

This report is made possible by the excellent summaries from the meteorological services of Reunion and Mauritius. The Reunion summary was translated by Vicki Jones of NOAA. The Mauritius summary is a new technical report series similar to reports they published prior to 1939. The tracks are shown in figure 17, and a brief summary for the season is given in table 7.

Six tropical cyclones (tropical storms and hurricanes) formed in the South Indian Ocean (west of 100°E) this season. While this is well below the average of 11, 3 reached hurricane strength and 2 of these were severe. Audrey opened the season on November 20, and Heliotrope closed it on about April 10. Barbara, Clotilde, and Danae were the hurricanes. Barbara occurred in December. She passed about 90 mi north of Tromelin Island where winds of 51 kn, with gusts to 68 kn, were recorded. Barbara's maximum winds were estimated at 85 kn with gusts to

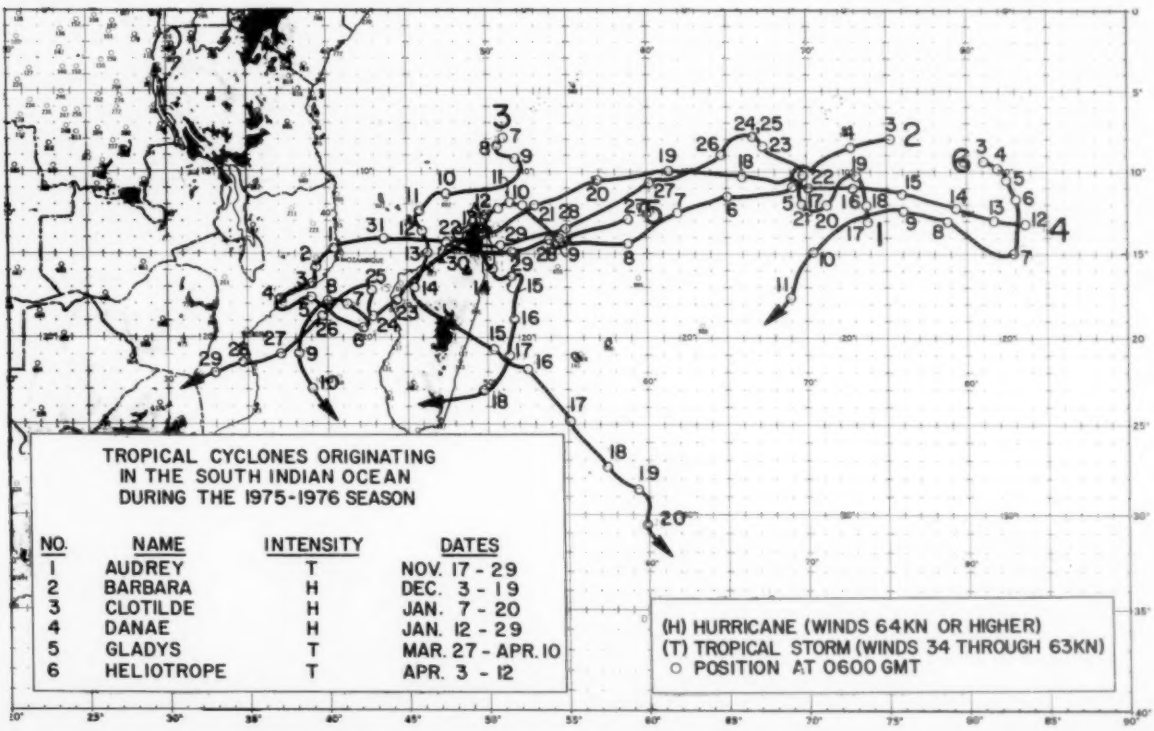
TROPICAL CYCLONES ORIGINATING
IN THE SOUTH INDIAN OCEAN
DURING THE 1975-1976 SEASON
NO. NAME INTENSITY DATES
1 AUDREY T NOV. 17 - 29
2 BARBARA H DEC. 3 - 19
3 CLOTILDE H JAN. 7 - 20
4 DANAE H JAN. 12 - 29
5 GLADYS T MAR. 27 - APR. 10
6 HELIOTROPE T APR. 3 - 12
(H) HURRICANE (WINDS 64 KN OR HIGHER)
(T) TROPICAL STORM (WINDS 34 THROUGH 63 KN)
○ POSITION AT 0600 GMT

Figure 17.--South Indian Ocean tropical cyclones for the 1975-76 season.

Table 7.--South Indian Ocean tropical cyclones, 1975-76

Number	Name	Intensity	Dates	Maximum wind (kn)*	Lowest pressure (mb)*
1	Audrey	T	Nov. 17-29	52	995
2	Barbara	H	Dec. 3-19	85	980
3	Clotilde	H	Jan. 7-20	135	980
4	Danae	H	Jan. 12-29	135	955
5	Gladys	T	Mar. 27-Apr. 10	60	998
6	Heliotrope	T	Apr. 3-12	45	1000

*estimated
T - tropical storm; H - hurricane

105 kn. When she crossed the north coast of Madagascar on the 12th, Vohemar was buffeted by 56-kn winds that gusted to 65 kn.

Clotilde and Danae were the big storms. Both had winds that were estimated at about 135 kn, although Clotilde's minimum pressure was about 980 mb, while Danae's dropped to 955 mb. Both formed in January, Clotilde on the 9th and Danae (named Terry by the Australians) on the 11th. They moved across the Malagasy Republic within a week of each other. On the Island, they left 16 dead, 26 injured, and 8,850 homeless.

When Clotilde moved ashore over Madagascar, Majunga, on the west coast, was blasted by 90-kn plus winds for 15 hr. Maximum winds reached 97 kn with gusts to 125 kn. As Clotilde recurved and headed for the open southern seas, Danae moved westward across the tropical waters. She brushed Agalega with 78-kn winds on the 20th. After turning southwestward, this blockbuster came ashore over Madagascar near Sambava. She weakened slightly upon crossing the rugged mountains of Tsaratanana. Danae regained some of her intensity as she crossed the Mozambique Channel and landed on the African coast about 100 mi south of Beira, Mozambique.

At Sambava pressure fell to 965 mb, while winds climbed to 100 kn. Nossi-Bè reported gusts of 95 kn. No lives were lost on the island of Agalega, but there was a great loss of homes, buildings, and coconut palm groves. The anemometer there blew away when winds gusted to 86 kn. Peak gusts were estimated in the 130-kn range. Rainfall on the 20th and 21st totalled about 12.3 in.

HURRICANE BELLE SALT DAMAGE

Hurricane Belle, which passed over the northeastern United States on August 10, 1976, caused more than $10 million in salt damage to cash crops and nursery trees throughout Long Island and southern Connecticut. Salt dessication destroyed cucumbers, potatoes, peppers, muskmelons, and cabbage. Despite their healthy appearance following the hurricane, tomatoes rotted within 2 days after picking. Evergreen trees and shrubs turned brown. Belle was the first storm to cause such severe salt damage since hurricane Inez struck the southeast coast of Florida in 1966.

Agriculture officials attribute the severe damage to the lack of heavy rain during and after the storm. Rainfall had ceased before the eye of hurricane Belle swept over Nassau County on Long Island, permitting the salt from the dry winds to accumulate on the vegetation. For a week after the storm, clear weather, with temperatures rising to 27°C, persisted until rain rinsed off the salt. During the dry period, plant tissues absorbed abnormally large amounts of salt, creating an osmotic imbalance which caused plants to expel water needed for photosynthesis and growth. Heavy dew and fog dissolved the salt deposits, so that as plants began to absorb moisture through the leaves to help compensate for the water loss, they further increased their salt content. As a result of dessication, some leaves turned brown and withered, while many others died and fell off.

The experience of two Long Island farmers provided unusual confirmation that salt had caused the damage. During the hurricane, the farmers pumped water through their aluminum irrigation lines to weight the lines and thereby minimize wind damage. The following week their crops appeared normal, while their neighbors' crops wilted. The irrigation water had prevented salt from building up on the crops.

In response to the salt shock, many fruit trees released leaf and flower buds which had been initiated during June. Apple trees developed new blossoms at the same time as their fruit approached maturity. Lilacs flowered so extensively that few buds remained unopened for next spring's bloom. Agriculture officials likened the unseasonable growth to the response of deciduous trees severely defoliated by the gypsy moth. Since bud formation, triggered by length of daylight, normally occurs during the long days of June, officials were skeptical that new buds would form during the shorter days of September and October. Most trees and shrubs, however, still have ample buds for a full bloom next season.

Many officials fear that the recent reflowering cycle will dissipate valuable carbohydrate reserves needed to survive the winter and fuel the budding process next spring. Plant tissues that began to grow in response to the recent shock will be extremely susceptible to an early frost, and nursery owners expect a high mortality among their younger woody plants. Many 1- and 2-year-old plants have already died. Although the salt dessication "burned" many crops black, most damaged plants were annuals, and their loss will not affect next year's crop. Farmers in the stricken region are eligible for Farmers Home Administration loans and Internal Revenue Service tax rebates to help cover crop losses from the hurricane.

The Nuclear Regulatory Commission sent a research team to Long Island to determine whether the salt damage from hurricane Belle resembled the annual dry season plant damage downwind from the nuclear power station on the Hudson River at Indian Point, N.Y. As the water level decreases in the Hudson during the dry season, the station's cooling system begins to take up brackish water from the river. Computer simulation models suggest that salt particles emitted from the cooling towers might be accumulating on the vegetation downwind, causing the annual plant loss. Hurricane Belle's damage to Long Island vegetation constitutes the first large-scale confirmation of the damage theory.

FAREWELL 1976

November 30 was the final day of the 1976 North Atlantic hurricane season. Although a few tropical storms have occurred during the winter months over the past century, their development during that time is considered quite unlikely.

During 1976 there was a total of eight named storms

of which six were hurricanes. This compares to an average of nine named storms and six hurricanes over the past several decades.

An unusual feature of the 1976 season is that there were no storms in the Gulf of Mexico or Caribbean Sea. The only other year with an absence of both Gulf of Mexico and Caribbean storms during this century was 1962.

Hurricane Belle and tropical storm Dottie were the only storms to strike the United States. Belle remained a short distance offshore as she moved northward from east of Cape Hatteras, N.C., until she crossed Long Island, N.Y., and moved into southern New England on the night of August 9. There were five fatalities and estimated damages of $250 million caused by Belle. Tropical Storm Dottie moved inland near Charleston, S.C., on the night of August 20. Dottie was a relatively weak tropical storm, and there were no casualties or damage attributed to her.

On the Editor's Desk

NOMINATIONS SOUGHT FOR 1976 SEAMANSHIP TROPHY

Nominations for the award of the American Merchant Marine Seamanship Trophy, based on events which occurred in 1976, are now being sought. The trophy was established in 1962 to give recognition to U.S. citizens for deeds exemplifying the highest traditions of seamanship and maritime skills. It applies to any size vessel and is for individual effort only. The recipient must be a U.S. citizen.

A select committee of maritime labor and management officials and government representatives appointed by the Assistant Secretary of Commerce for Maritime Affairs reviews the nominations and worthiness of the candidates.

Nominations should be sent to the Maritime Administration, Eastern Region Director, 26 Federal Plaza, New York, NY 10007, and must be received by March 1, 1977. The following information should be included: name of candidate, vessel and owner, date of incident, and time, place, and weather conditions.

NATION'S FASTEST-GROWING RADIO NETWORK LACKS GLAMOUR

The fastest-growing radio network in America is uniquely lacking in glamour. Its broadcasts have never given big-league talent the slightest feeling of job insecurity. Its operating decisions are made, not in the boardrooms of Madison Avenue, but the back rooms of nondescript offices.

Yet, it has caught on spectacularly with millions, a fact all the more remarkable because one must buy a receiver with a special frequency to hear the broadcasts.

The network is called NOAA Weather Radio, and its success is a testimonial to the unending fascination of the American public with that phenomenon called weather. For the localities it serves, it provides important local weather information at the punch of a button or the twist of a dial.

NOAA Weather Radio began in a small way in the mid-60's. Then, it was a new service to boaters and fishermen. Today, it has more than 100 stations. By 1980, it is expected to have more than 300 outlets ready to serve nine-tenths of the country's population.

It gives the Weather Service a potent, fast-moving technique for spreading storm and flood warnings, and its potential for the saving of life is considered high.

When a natural disaster threatens, forecasters move quickly to broadcast warnings, taped or live, accompanied by vital safety information with immediate utility. Lest the spoken word go unnoticed, forecasters can trigger "warning alarm" receivers to emit a high-pitched tone of unmistakable urgency. In some receivers, the tones activate a siren which alerts the listener to turn up the volume; in others, they automatically increase the decibels so the weather message is certain to be heard. This feature is especially useful in schools, hospitals, and other institutions.

NOAA Weather Radio broadcasts are retransmitted over cable television in some locations; some cable operators alert subscribers to urgent messages with beepers loud enough to waken sleepers. Others offer a voice override enabling local public safety officials to blank out the cable TV audio and issue weather warnings--a valuable timesaver when seconds count.

In January 1975, NOAA Weather Radio was designated by the White House as the sole Government-operated radio system to provide warnings directly into homes, not only for natural disasters but for nuclear attack.

In less dramatic times, however, the "Other" Network just goes on about the weather, 24 hr a day, 7 days a week. Taped in Weather Service offices, the transmissions feature the latest observations and forecasts and a variety of specialized weather information depending upon the locality. Messages average 4 to 6 min, are repeated without pause, and are revised as required, ordinarily every 2 or 3 hr, to provide the listener with the very latest information.

The broadcasts are heard in most locations in a radius of about 40 mi, but effective range varies with the terrain and the receiver.

Broadcasts contain a wide variety of specialized information. Along the coasts and the Great Lakes, the concentration is on information for boaters, fishermen, and others whose work or play take them to the water. Where the potential for flooding is strong and waterway navigation is important, river forecasts are emphasized.

In farm country, special information is issued for orchardists, ranchers, and others involved in agricultural operations.

To hear this unique service, one must obtain a special high-band receiver capable of picking up 162.40, 162.55, or 162.475 MHz. They cost from $10 to well over $100, and performance varies widely. Some have automatic warning capability; others do not. Also on the market are numerous multi-purpose

radios with the "weather band."

Quality of reception varies with the terrain and other factors. NOAA recommends that prospective buyers make final acceptance of a receiver conditional upon a test in the setting where it will be used, and that institutional users purchase high-quality commercial receivers.

PHILIPPINE EARTHQUAKE AND TSUNAMI

Shortly after midnight local time on August 16-17, 1976, a severe earthquake struck the Moro Gulf in the Philippine Islands, generating a 5-m high tsunami which caused extensive damage along coastal regions. According to reports, the quake, which was the second largest this year, was felt as far away as Legazpi, 700 km north of the epicenter. The National Earthquake Information Service (NEIS) in Golden, Colo., reported the following preliminary data:

Origin time:	161109.2 UTC, August 16, 1976
Epicenter:	7.1°N, 123.5°E
Magnitude:	8.0 Ms
Depth of focus:	Shallow

The tsunami inundated regions throughout the Sulu Archipelago and around the Moro Gulf. Together, the quake and tsunami caused widespread damage, collapsed buildings and bridges, and disrupted communications networks and electrical systems.

As of 1800 GMT on August 17, Philippine authorities reported over 1,700 dead, several hundred injured, and over 1,300 families homeless. They fear the death toll will rise above 2,000 as search operations continue. Although some people were killed when buildings collapsed during the quake, most deaths resulted from drowning during tsunami inundation.

According to a local Red Cross official, the disaster was the "most devastating in Philippine history." Philippine President Ferdinand Marcos proclaimed a "state of calamity" on Mindanao, Sulu, Basilan, and Tawi-tawi, the four most heavily damaged islands. The military has been mobilized to conduct relief operations, and planes have been transporting food and medicine to the stricken regions. Rescuers have been digging through the rubble, using cranes, bulldozers, and their bare hands to recover trapped victims.

According to the Philippine Red Cross, at least 15 aftershocks were felt in Cotabato prior to 0240 GMT on August 17. Shortly thereafter, a major aftershock rocked the island of Mindanao. The NEIS reported that the aftershock had a magnitude of 6.7 Ms; an origin time of 041934.1 UTC, August 17, 1976; an epicenter at 8.2°N, 123.2°E; and a shallow focal depth.

NOAA, UNIVERSITY SCIENTISTS TRACK ELECTRIC CURRENT IN AURORA BOREALIS

Scientists from NOAA and five universities have used satellite measurements to put together a picture of powerful electric currents flowing in the aurora borealis which cause magnetic disturbances on the ground below.

The researchers used simultaneous measurements from two polar-orbiting satellites and a number of ground stations. The data are stored at NOAA's National Geophysical and Solar Terrestrial Data Center in Boulder, Colo. The group's findings were presented at the fall annual meeting of the American Geophysical Union in San Francisco.

The Sun radiates a continuous flow of energetic particles known as the solar wind which distorts the Earth's magnetic field, flattening it on the sunward side and drawing it into a long tail on the side away from the Sun. Some of the energetic particles of the solar wind become trapped in this tail. During the magnetic storms that follow a solar flare, this stored energy is released and flows along magnetic field lines into the ionosphere at the Earth's polar regions. Brilliant auroras, containing powerful electric currents called auroral electrojets, result.

Before the advent of satellites, auroras and their associated currents had to be studied from the ground with cameras and magnetometers. The magnetometers measured only the total magnetic field effects from several possible source currents. Scientists could infer from magnetic changes on the ground that powerful currents were flowing aloft but could not tell where and in what directions.

The TRIAD satellite, launched by the U.S. Navy and Johns Hopkins University, carries a three-component magnetometer, which can measure the strength of vertical currents which supply the auroral electrojets. From it and another satellite launched by the Air Force's Defense Meteorological Satellite Program and ground-based magnetic measurements made at stations in Alaska, Canada, and the Soviet Union, they obtained simultaneous measurements of the currents and auroras for 30 cases. They have fused these measurements into a composite diagram showing the direction of currents flowing horizontally in the ionosphere, vertical currents flowing along magnetic field lines, and the resulting magnetic perturbations on the ground. These were related to the visual aspects of the aurora and time of day.

NOAA SCIENTISTS USE ADVANCED COMPUTER TO STUDY WEATHER

NOAA has put the world's fastest, fully-operational computer to work on one of the world's most complicated problems--understanding and predicting weather and climate.

The "Advanced Scientific Computer," the only one of its kind in existence, is running at full capacity at NOAA's Geophysical Fluid Dynamics Laboratory in Princeton, N.J., following installation, refinements, and modifications which have taken more than a year to accomplish. Now, Commerce Department scientists at the Princeton laboratory are using the computer to construct and test numerical models of the atmosphere, oceans, and all the complex processes that determine the weather.

Built by Texas Instruments, the new computer can perform 50 million additions per second, two to five times faster than any previous computer. Its central memory can store 1 million words. This enormous capacity is necessary for the work of the laboratory, constructing computer models for the Earth's atmosphere and oceans, and for a multitude of smaller-scale phenomena, such as hurricanes, jet streams, and ocean currents.

With the computer, a mathematical universe can

be set in motion, allowing the scientists to see how well their model simulates the behavior of the real atmosphere or predicts the effects of a change in the system, such as a decrease in stratospheric ozone. The scientist plugs a set of initial conditions--prevailing temperature, humidity, and wind distribution, for instance--into the model, and the computer calculates how these conditions would evolve over time in the model universe.

Such calculations would be impossible without computers, but even on the fastest computers, they can take days. On slower computers, the calculations might take longer than the period of time being simulated, so that the course of events in the real world could render the scientists' questions academic.

The mammoth computer and its supporting facilities occupy an entire floor of the laboratory. The computer itself is divided into two sections, separated both physically and environmentally. In an outer control room are the data handling facilities--cardpunches, printers, magnetic tape drives, and cathode ray screens--the intermediaries between human thought and electronic circuits.

The heart of the computer is sequestered in a large, temperature-controlled back room. While other computers in existence have only one or two main computing elements, the computer at the Geophysical Fluid Dynamics Laboratory has four, the really distinguishing factor.

A maze of metal cabinets contains the computer's "brains," the circuits that perform the calculations. The solitude of this room, usually barren of human traffic, contrasts sharply with the bustle of the data handling section. But it is not silent; here the click and clatter of the outer room are replaced by the drone of cooling fans, forcing cold air through an 18-in space under a foot-chilling metal floor. Water at 54°F running through copper plates set between the circuits maintains the internal temperature of the cabinets.

Strategically placed television cameras allow operators in the control room to keep an eye on the delicate internal organs of the machine. Smoke detectors sniff for the first symptoms of fire, and, if they sense smoke, an alarm warns personnel to evacuate, and the room is flooded with flame-smothering carbon dioxide.

Around the computer's fringes are a maintenance laboratory with facilities for checking and replacing the circuit boards that make up the computer's "thought processes"; a vault for storing magnetic tapes carrying programs and data; a cardpunch room where each problem is translated into the language of the computer and punched on cards; a machine that can convert computer results into various visual forms--films, maps of circulation patterns, or profiles of the ocean bottom; and offices for 27 fulltime analysts and technicians who operate and maintain the computer.

A "user's mailbox" area, reminiscent of a small-town post office, is lined with open, white cubbyholes, one for each regular user of the computer. This is where a scientist with a problem for the computer hands it to the computer operators. When the result spews out a few minutes, or perhaps hours, later the technicians place it in the user's box and flip a switch that illuminates a small light in the scientist's office upstairs, signaling that the job is done.

During the 21-yr history of the Geophysical Fluid Dynamics Laboratory, its scientists have worked with a variety of computers, and for a while they were the principal users of one owned by Princeton University. Now, with fulltime access to this most sophisticated computer, the laboratory's work can proceed at an accelerated pace, and more complex models can be fashioned and tested to increase understanding of the Earth's oceans and atmosphere.

PLATE TECTONICS PROVIDES CLUES TO LOCATION OF MINERAL RESOURCES

According to the plate tectonics concept, the Earth has a rigid outer shell or crust about 100 km thick (60 mi) called the lithosphere, which apparently floats on a plastic layer--the asthenosphere (fig. 18). There are two major types of crust, one composed of continental granite about 30 km thick and one of oceanic basalt about 10 km thick. The crust is composed of many plates, some of continental size, which are delineated by narrow zones where, when one rubs against another, earthquakes are produced. Any two adjacent plates are either diverging or converging. Where moving apart, new lithosphere ascends as the sea floor spreads. Where converging, one plate descends under another and is resorbed (subduction). Or, one plate may temporarily override another (obduction) before reverting to a status of subduction. Three sides of the Pacific are bounded by converging plates which cause the oceanic trenches; the lithosphere descends at an angle and at rates comparable to those of sea floor spreading in other areas. The Pacific is becoming smaller in size, but other oceanic basins, such as the Atlantic, are growing--thus the Earth maintains a more or less constant diameter.

Rates of oceanic growth or shrinking are in terms of a centimeter or so per year, so that a time span of hundreds of millions of years is involved in the creation of a basin the size of the Atlantic or reducing and closing the Pacific.

Along convergent plate boundaries around the Pacific are to be found geothermal energy releases in the form of active volcanos, thermal springs, fumaroles, geysers, and high values of heat flux caused by friction, chemical reactions, and energy from the Earth's interior. Some of this energy already is being used at sites in the western United States, Japan, and New Zealand.

It has been found that areas of offshore petroleum potential also are related to convergent plate boundaries around the Pacific. The trenches and island arcs act as barriers that catch sediment and organic material from the continents and ocean basin suitable for the formation of this type of fossil potential energy. Restricted circulation reduces the oxygen content in the seawater, thus preserving the organic matter. Geothermal heat may facilitate its conversion to petroleum, and tectonic forces may cause deformation of the sediment so that the petroleum is trapped (fig. 19).

Comparatively rich mineral deposits have been located along divergent plate boundaries in the oceans. The richest known submarine metallic sulfide deposits have been found in basins along the center of the Red Sea--the earliest stage in the growth of an ocean basin--where two continents are rifting apart. The deposits are saturated with and overlain by salty

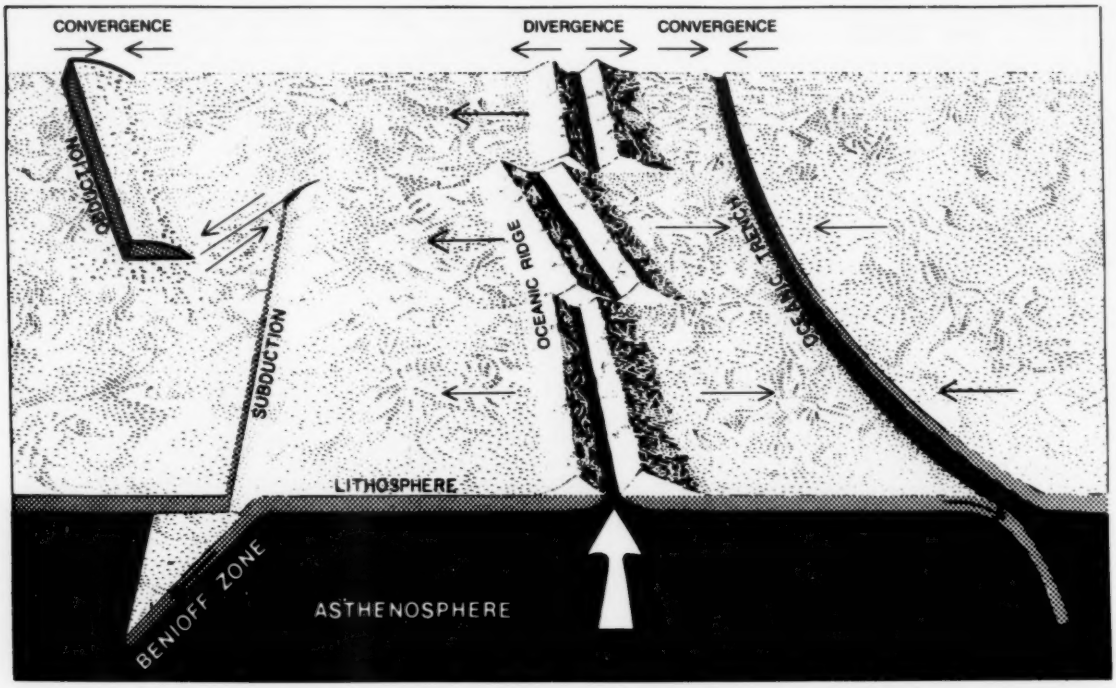

Figure 18.--Plates move like gigantic conveyor belts from a divergent plate boundary (oceanic ridge) to a convergent plate boundary where they either descend at an oceanic trench (subduction) or override the adjacent plate (obduction).

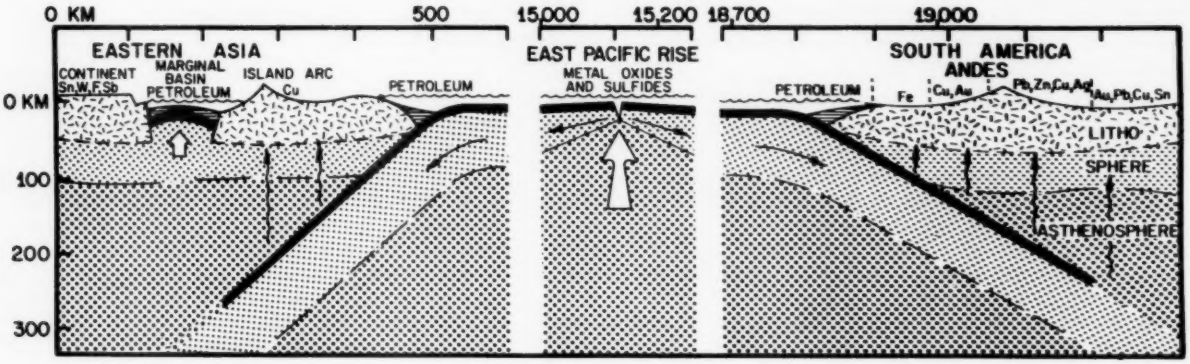

Figure 19.--An east-west section across the central Pacific region shows the relation of petroleum and metal deposits to divergent and convergent plate boundaries.

brines which carry the same metals in solution as those present in the sulfide deposits. More advanced growth stages of divergent plate boundaries are represented by the Mid-Atlantic Ridge and East Pacific Rise. Hydrothermal fields from hot springs flowing from fractures in the crust are formed along the ridges, and manganese oxide layers (40 percent pure) and traces of iron and copper may cover areas of the sea floor for many kilometers from the ridge crest. Manganese nodules contain about 10 percent manganese, but appreciably more iron and copper, indicating a more rapid rate of accumulation.

According to a model of metallogenesis, at divergent plate boundaries cold dense seawater descends through fractures in the basaltic material of an ocean ridge and is heated by contact with hot molten rock (magma). The warm, less dense seawater rises through the cracks and leaches metals from the basalt. They are then transported in solution, mixed with chlorides in the seawater, and precipitated to form the deposits of metallic sulfide, including copper, iron, and possibly gold.

Deposits of precious metals (including gold, silver, and platinum) and base metals (including antimony,

copper, lead, mercury, and tin) are formed along convergent plate boundaries around the Pacific. Also found are ferro-alloy metal deposits including chromium, cobalt, manganese, molybdenum, nickel, tungsten, and vanadium.

On about two-thirds of the Pacific sea floor there are nodules containing varying percentages of manganese, copper, nickel, and cobalt. They are formed by hydrogenous processes in which the metals are precipitated from seawater from the interstices of underlying sediments.

The simplest models of metallogenesis along convergent plate boundaries indicate that the metals are extracted from seawater-saturated oceanic crust as it undergoes partial melting under conditions of increasing temperature and pressure during descent of the oceanic lithosphere along a convergent zone. The metals ascend as components of magmas, are concentrated in fluids released from the magmas, and then deposited.

The sudden, recent reorientation of relatively static geological science to one of active application is pointing the way to the possible discovery of hitherto unsuspected, accessible deposits of energy and mineral resources in many parts of the world. The geological models are becoming more complex as factors are added to successively approximate the actual deposits. But, with further development, they should be an important factor in bringing this to pass.

NEW REGULATIONS FOR TANKERS AND POLLUTION

The Coast Guard has approved regulations designed to reduce pollution from seagoing U.S. tank vessels engaged in foreign trade and foreign tank vessels carrying oil into U.S. waters.

The new regulations, which appeared in the December 13 issue of the Federal Register, are an extension of the pollution prevention regulations now in effect for U.S. tank vessels in domestic trade.

The most recent rules require new and existing foreign vessels entering U.S. ports to meet the same design and equipment requirements as new and existing U.S. tank vessels, including provisions for segregated ballast on new tankers over 70,000 deadweight tons.

The operating requirements for foreign vessels and U.S. vessels still differ, however. Regulations governing discharges of oily mixtures from U.S. vessels on the high seas are not applicable to foreign ships on the high seas because of U.S. jurisdictional limits. International law, however, establishes limits on the discharges by all vessels in areas beyond the 12-mi contiguous zone.

The segregated ballast requirement for new foreign and U.S. vessels will practically eliminate the need to add ballast water in cargo tanks. Coast Guard officials point to ballasting of cargo tanks with water and the subsequent cleaning of those tanks as the principal worldwide source of oil pollution. This requirement should further reduce the number of oil spills from tanker collisions and groundings.

Another regulation for new vessels requires slop tanks for consolidating waste from tank washings, oil residues, and dirty ballast residues. Also required are tanks for collecting oily residue from fuel, lubricating oil purification and oil leakages in machinery spaces, an oil discharge monitoring system, and oily water separating equipment.

In addition, new vessels must have improved ability to withstand flooding damage, especially flooding of the engineroom space, without the vessel becoming a total loss.

Existing tank vessels will also be affected by the regulations and required by 1980 to be refitted with slop tanks, residue tanks, oil discharge monitoring systems, and oily water separating equipment.

Copies of the final environmental impact statement for these regulations are available upon request from Executive Secretary, G-CMC/81, U.S. Coast Guard Headquarters, Washington, D.C. 20590.

HAPAG LLOYD RECEPTION MARKS 100TH VOYAGES OF FOUR CONTAINERSHIPS

A reception and luncheon marking the 100th voyages of Hapag Lloyd's four containerships in the trade between North Atlantic ports and Europe was held on November 10 onboard the line's ELBE EXPRESS at her berth at Elizabeth, N.J. The ELBE EXPRESS, which arrived in the Port of New York a day late because of stormy weather, was followed in succession by the WESER EXPRESS, MOSEL EXPRESS, and ALSTER EXPRESS, each also making their 100th trips on the route.

The four 15,400 deadweight ton, 20-kn vessels were jumbozied 3 yr ago, and each now has a capacity for 1,100 20-ft equivalent containers.

The ships are fitted with fin stabilizers which reduce roll to six degrees even in the roughest weather.

U.S. general agents for the line is United States Navigation Inc. The following letter was presented to them by Walter J. Stoddard, New York Port Meteorological Officer:

Forecast Office
30 Rockefeller Plaza
New York, New York 10020

November 12, 1976

Mr. Edward C. Oelsner, President
United States Navigation Inc.
17 Battery Place
New York, New York 10004

Dear Sir:

It is with gratitude that the National Weather Service and I convey our congratulations to the officers and seamen of the Hapag Lloyd Shipping Company on their 100th crossings of four of their vessels.

I have had the pleasure to service these vessels, from time to time, and have enjoyed the courtesy and cooperation they extended to me through the years.

It is this kind of diligence and collaboration that has made the world-wide weather watch a success that it is.

Sincerely,

Walter J. Stoddard
Port Meteorological Officer

LETTERS TO THE EDITOR

HONG KONG PHOENIX SHIP'S WEATHER OBSERVATIONS

Anthony E. Rippo, Port Meteorological Officer at Terminal Island, Calif., forwarded these Ship's Weather Observations forms and chart from Captain R. G. MacDonald of the motor vessel HONG KONG PHOENIX. These are only samples of the outstandingly neat and complete forms that Captain MacDonald consistently submits (figs. 20 and 21). Two observation forms have been joined together below 08/1800 for convenience of portrayal. Their clarity makes them very easy to process for climatological records.

The HONG KONG PHOENIX was approaching the Formosa Strait and Hong Kong slightly ahead of typhoon Billie as indicated on the chart. Their closest approach together was at about 0900 on the 9th, but the lowest barometer reading was 992.8 mb at 1900 as the storm moved into the Strait. The strongest wind and highest waves had been earlier, late on the 8th, when the ship was northwest of the storm.

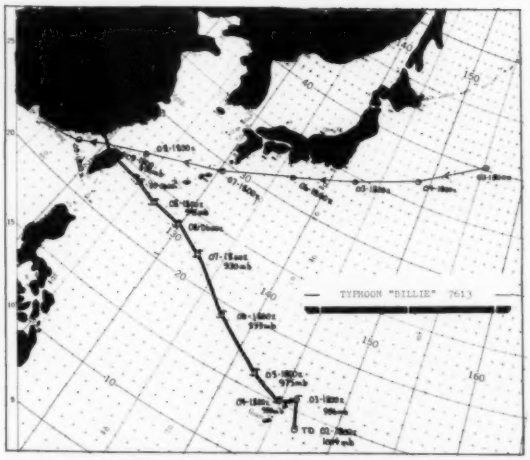

Figure 20.--Chart submitted by the HONG KONG PHOENIX.

SHIP'S NAME: "HONGKONG PHOENIX" | CALL SIGN: 9VBR | MONTH AND YEAR: AUGUST 19 76 | VOYAGE FROM: LONG BEACH | BAROMETER NO.: D192 | COUNTRY OF REGISTRY: SINGAPORE | VOYAGE TO: HONGKONG | CORRECTION APPLIED: NIL

NOAA FORM 72-1 — U.S. DEPARTMENT OF COMMERCE — NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION — NATIONAL WEATHER SERVICE

SHIP'S WEATHER OBSERVATIONS

GENERAL INSTRUCTIONS (See observing handbook for more details)

1. Fill in all blanks on upper left-hand side of this form.
2. Check appropriate box in column 32.
3. Before entering, convert
   a. all temperatures to °C.
   b. all pressures to millibars.
   c. if conversion tables not available, enter values as observed, followed by letters or abbreviations for the first entry on each form, ("77.5°F", "29.905 in.", etc.)
4. Begin a new sheet each month, voyage, ocean and quadrant.
5. Code for transmission unshaded columns. See observing handbook, Chapter 1, for coding messages and handling missing data.

99	Lat.	Qc	Long.	YY	GG	iw	N	dd	ff	VV	ww	W	PPP	TT	Cl	Cm	Ch	Ds	vs	A	pp	0	T$_x$T$_x$	T$_n$T$_n$	E$_d$T$_d$	1	T$_w$T$_w$T$_w$	T$_T$	3	P$_w$P$_w$	H$_w$H$_w$	1$_w$a$_w$	P$_w$	H$_w$H$_w$	Remarks	Check if sent by radio
99	314	1	1350	07	00	3	5	25	20	98	02	1	10	121	26	5	24·5	3	3	3	3	5	5	3	5	01	0	//	24	1	28·0	5	3	05	05	24	5	06		W.K. ✓ %
99	306	1	1338	07	06	3	5	25	06	98	02	1	10	111	27	7	21·5	5	2	3	4	4	5	3	7	06	0	//	22	1	28·0	7	3	00	00	32	5	02		C.A. ✓ %
99	298	1	1320	07	12	3	3	15	10	98	02	1	10	109	27	5	25·5	2	2	3	3	1	5	3	3	04	0	//	25	1	29·0	5	3	04	03	16	5	02		W.K. ✓ %
99	291	1	1305	07	18	3	8	00	00	98	03	1	10	091	26	5	24·5	8	5	3	9	3	5	3	7	11	0	//	24	1	29·0	5	3	00	00	14	7	04	2045-2105z Shower mod.	C.A. ✓ %
99	284	1	1288	08	00	4	4	09	27	98	01	8	10	067	29	3	27·0	2	2	5	0	6	5	4	7	03	0	//	26	1	29·0	3	3	06	08	11	0	06	08-0000z Vessel coming	R.G.M. ✓ %
99	278	1	1271	08	06	4	4	05	28	98	05	0	10	041	30	2	26·5	3	2	4	0	5	5	4	7	17	0	//	25	1	29·0	2	3	06	08	12	0	09	under influence of Typhoon "BILLIE"	R.G.M. ✓ %
99	268	1	1253	08	12	4	6	05	24	98	03	1	10	030	29	6	26·8	5	2	5	0	5	5	4	4	00	0	//	26	1	29·0	6	3	06	07	12	0	07		R.G.M. ✓ %
99	257	1	1237	08	18	3	8	02	33	98	03	2	10	002	27	5	25·3	7	8	4	9	+	5	4	7	19	0	//	25	1	29·0	5	3	06	08	05	0	08		C.A. ✓ %
99	263	1	1229	08	21	4	4	02	30	98	02	2	9	994	28	8	26·6	2	3	4	0	3	5	4	7	08	0	//	26	1	29·0	8	3	07	11	11	7	15	1355-2010z Heavy Rain Showers	R.G.M. ✓ %
99	260	1	1220	09	00	4	7	35	28	97	81	2	10	001	28	8	26·8	4	3	4	2	5	5	4	2	07	0	//	26	1	29·0	8	3	06	08	11	7	10		R.G.M. ✓ %
99	257	1	1212	09	03	4	7	35	28	98	02	8	10	000	29	0	26·5	4	7	3	9	6	5	4	5	01	0	//	26	1	29·0	0	3	06	08	11	7	10		R.G.M. ✓ %
99	253	1	1205	09	06	4	7	35	25	98	02	2	9	991	29	6	26·4	1	7	3	9	9	5	4	7	09	0	//	25	1	29·0	6	3	06	07	09	8	06		R.G.M. ✓ %
99	250	1	1198	09	09	4	7	02	20	98	02	2	9	974	29	5	26·1	1	3	3	9	+	5	4	7	17	0	//	25	1	28·0	5	3	06	04	07	8	06		R.G.M. ✓ %
99	245	1	1192	09	12	4	5	31	09	98	01	2	9	976	29	3	24·5	3	0	8	9	2	5	4	3	02	0	//	26	1	29·0	3	3	03	01	00	+	00		R.G.M. ✓ %
99	240	1	1186	09	15	3	8	25	10	96	81	6	9	968	28	5	25·5	6	6	1	2	+	5	4	8	08	0	//	24	1	29·0	5	3	02	01	00	+	00	1300-1400z Heavy Rain Showers	W.K. ✓ %
99	235	1	1180	09	18	3	8	25	12	97	02	2	9	934	26	5	25·0	8	8	3	2	+	5	4	7	34	0	//	24	1	28·0	5	3	05	03	23	6	04	0325-1900z Lowest System reading 992.8mb	C.A. ✓ %
99	230	1	1173	09	21	4	8	25	22	98	02	2	9	935	28	8	27·0	8	0	9	1	+	5	4	3	01	0	//	26	1	29·0	8	3	06	06	22	5	04	09/1600-1900z Typhoon passing over Taiwan	R.G.M. ✓ %
99	227	1	1165	10	00	4	8	25	25	98	02	2	9	948	29	1	27·0	8	0	9	1	+	6	4	3	13	0	//	26	1	29·0	1	3	06	06	22	5	05		R.G.M. ✓ %
99	223	1	1150	10	06	4	8	24	21	97	02	2	9	954	29	7	27·3	8	8	4	+	+	6	3	5	00	0	//	27	1	29·0	7	3	06	04	24	5	04	BAR. HONGKONG 10-1002z	R.G.M. ✓ %
99	Lat.	Qc	Long.	YY	GG	iw	N	dd	ff	VV	ww	W	PPP	TT	Cl	Cm	Ch	Ds	vs	A	pp	0	T$_x$T$_x$	T$_n$T$_n$	E$_d$T$_d$	1	T$_w$T$_w$T$_w$	T$_T$	3	P$_w$P$_w$	H$_w$H$_w$	1$_w$a$_w$	P$_w$	H$_w$H$_w$		

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Figure 21.--Ship's Weather Observations from Captain MacDonald of the HONG KONG PHOENIX.

FIELD GUIDE HELPS IDENTIFY WHALES, DOLPHINS, AND PORPOISES

A field guide to help identify whales, dolphins, and porpoises in the western North Atlantic has been published by the National Marine Fisheries Service.

"Whales, Dolphins and Porpoises of the Western North Atlantic - A Guide to Their Identification" also includes those animals found in the Caribbean Sea, Gulf of Mexico, and the eastern coastal waters of the United States and Canada.

While the 176-page volume is intended as an aid to identifying living animals at sea, it also is expected to assist in the reporting of stranded specimens, a major source of material for museums. Appendices describe how and to whom data on live or dead whales, dolphins, and porpoises should be reported.

Photographs of the animals in their natural environment, supplemented by drawings and descriptions or tables distinguishing the most similar species, form the core of the guide (fig. 22).

Following the summary accounts of the species are five appendices covering tags and markings; how to record and report observations at sea; strandings and handling; forms and instructions for measurements; and institutions for information and for reporting strandings.

Also included is a bibliography of useful references on cetaceans in general and cetaceans of this region in particular, as well as a directory of species explanations.

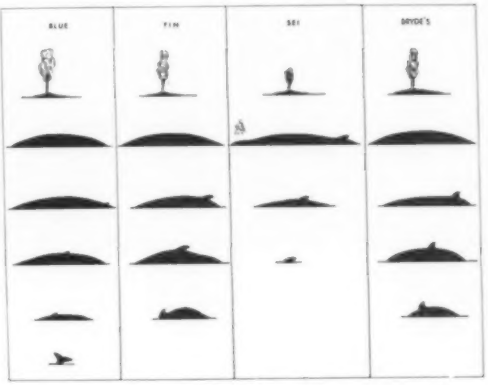

Figure 22.--"Swimming, blowing, and diving characteristics of blue, fin, sei, and Bryde's whales." An illustration from NMFS's new guide.

The NOAA Technical Report NMFS Circular 396, Catalog No. C-55.13, is for sale at $2.45 each by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

MARINE WEATHER REVIEW

The SMOOTH LOG (complete with cyclone tracks [figs. 24-27], climatological data from U.S. Ocean Station and Buoys [tables 9 and 10], and gale and wave tables 11 and 12), is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The ROUGH LOG is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both the SMOOTH and ROUGH LOGS, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

Smooth Log, North Atlantic Weather

July and August 1976

SMOOTH LOG, JULY 1976--The Atlantic was relatively quiet as would be expected in a summer month. The number of cyclone tracks was near normal, but diffuse. The tracks off the U.S. East Coast were more easterly than the normal northeasterly. Over the north-central ocean south of Greenland and Iceland, most storms had a definite tendency to curve northward then northwestward. There was one cyclone over the Mediterranean Sea, and the few that affected Europe did nothing to alleviate the drought.

The mean sea-level pressure pattern for the month was nearly identical to the climatological normal, except for two shallow Lows (1010 mb) which were missing over Iceland and Norway. The normal shows three shallow Lows--a 1008 mb over Cape Chidley and the two mentioned above. The Cape Chidley Low was 1008 mb, but was west of Angava Bay. The normal closed High was centered over the Greenland ice cap.

The Bermuda-Azores High was 1024 mb versus 1025 mb, and it was centered at 30°N, 40°W, slightly south of its climatological position.

There were many minor anomaly centers over the Atlantic portion of the hemisphere. The largest was a plus 4 mb off Bergen, Norway. There were two minus 3-mb centers, one near the Bay of Fundy and the other over the Azores Islands.

The upper-air pattern over the eastern United States and western Atlantic differed from climatology only in that the usual trough over the coast was more sharp. A minor ridge extended southward from the North Sea with the usual slight trough along longitude 10°W displaced to 20°W. The significant anomaly was plus 55 m over the North Sea.

The first tropical cyclone of the season, tropical storm Anna, was named about midday on the 30th.

Extratropical Cyclones--This LOW formed in a sharp trough associated with a north-south oriented front and was first analyzed on the 0000 chart of the 3d. At 1800 on the 2d, the DART AMERICA was west of the front at 44.2°N, 36°W, with 48-kn northerly winds. At 0000 on the 3d, PYATIDES KOMSOMOLA was near the front at 38.5°N, 28.9°W, with 40-kn westerly winds. At 1200, the 1003-mb frontal wave was near 51°N, 25°W. The DART AMERICA was traveling eastward at about the same speed as the front and had 40-kn gales. The waves were 10 ft. Far back to the west behind the same front and over the Gulf Stream, a SHIP reported 50-kn winds near 40.5°N, 69.5°W. The report contained only the position and wind, and the wind may have been associated with a thunderstorm.

On the 4th, the 1002-mb center was moving northward with only light winds. At 1200 on the 5th, the LOW was southwest of OWS Lima. The USDL (49.3°N, 11°W) reported 40-kn south-southwesterly winds. Early on the 6th, a LOW moving eastward, south of Kap Farvel, absorbed the circulation.

This frontal wave was first analyzed near Asheville, N.C., the home of the National Climatic Center, where its history will be preserved long after it is gone. The time may also have been significant--0000 on July 4. Twenty-four hours later, it was over the Gulf Stream, moving eastward at 1009 mb, causing no fireworks. At 0000 on the 6th, the WELSH CITY reported a thunderstorm near 37°N, 53°W. The frontal wave was racing under the influence of a short wave aloft. At 1800 the JAPAN CEDAR (41.7°N, 39.7°W) reported 35-kn winds, 15-ft seas, and 20-ft swells. By 1200 on the 7th, the 1007-mb wave was at 46°N, 25°W. South of the front at 39.2°N, 35.2°W, the PACDUCHESS had 52-kn southwesterly winds. The AMERICAN ALLIANCE was at 35.2°N, 30.2°W, with 40-kn winds during a thunderstorm.

On the 8th, the storm developed a larger circulation as it turned northward. At 1200 it was near 52.5°N, 15°W. At 0000 on the 9th, Valentia, Erie, on Dingle Bay measured 50-kn winds. On the 10th, the LOW was absorbed by another.

The Labrador Sea was the mother of this storm. It was first analyzed on the 1800 chart of the 7th and moved southeastward then eastward before turning northward on the 9th. It remained an open wave for most of this time. On the 9th, it passed around the edge of the previous storm and was the one that absorbed it. At 1200 the CAST BEAVER (52.5°N, 19.4°W) had intermittent heavy rain and 44-kn winds. At 1800 the PORYV, at 50°N, 27.7°W, had 40-kn westerlies. The LOW deepened rapidly on the 10th and 11th, and it was 978 mb at 0000 on the 11th near 57°N, 22°W. Ocean Weather Station Lima measured 16-ft seas and swells. At this time, the LOW became nearly stationary under an upper-air LOW near 56°N, 25°W, until the 15th. A short-wave LOW moved around the southern perimeter from the 12th through the 14th. On the 14th, another frontal wave associated with an upper-air short wave developed south of the center near 45°N. After its passage toward the northeast, the SEALAND MARKET was overtaken by 40-kn winds and 20-ft seas. On the 15th, the upper-air LOW retrograded westward, and the surface system could not survive.

This LOW formed over New England on the 11th in an area of weak gradient. On the 12th, the circulation was quite large as there was already cyclonic circulation present. The MOBIL LUBE (34°N, 75.3°W) had 35-kn winds, 10-ft seas, and 15-ft swells. The center was moving very slowly toward the southeast. At 0000 on the 13th, the pressure was 990 mb. At 0600 the CARBIDE SEADRIFT was hit by 35-kn gales and 10-ft seas at 38.5°N, 73.1°W. Late in the afternoon a ship near 36°N, 67°W, had a thunderstorm with 13-ft seas along the front. At 1200 on the 14th, the AMERICAN LEADER was slightly east of the front at 40.4°N, 58.4°W, with 36-kn gales and 15-ft waves.

The ISAR at 37°N, 60°W, was caught by 16-ft waves with frontal passage on the 15th. The LOW was weakening with little gradient southwest and west of its center. The area southeast of the front, between it and a 1028-mb HIGH, remained the only area with a tight pressure gradient. A ship near 38°N, 51°W, in that area found 35-kn gales and 16-ft swells.

On the 17th, the storm gained new life and started moving eastward at 1000 mb. As the center moved south of OWS Lima on the 18th, she measured 35-kn gales. As the storm neared Ireland, it turned northeastward. A Norwegian coastal station measured 35-kn gales on the 20th. The LOW continued northward into the Greenland Sea.

This report of high swells was connected with a long period of southwesterly flow between the Bermuda-Azores HIGH and various LOWs moving northeastward, northwest of the HIGH. Winds of 20 to 30 kn were the general rule. The seas and swells varied from 5 to 15 ft. At 0000 on the 14th, the NEDLLOYD DEJIMA found 8-ft seas and 23-ft swells at 37.6°N, 52°W, and the SEA-LAND ECONOMY found 16-ft seas and 8-ft swells near 31.5°N, 57°W.

A tropical LOW had persisted on and off for many days over Colombia with a center being analyzed south of Barranquilla at times. As the depression waxed and waned, the gradient over the southwestern Caribbean Sea also reacted. During the period of the 14th to the 17th, several ships reported gales. On the 14th, it was the LONG BEACH with 35 kn. On the 15th and 16th, the VELMA LYKES, sailing southeastward toward the Gulf of Venezuela, fought 44-kn easterly

winds with swells of 30 ft on the 16th. At 0000 on the 17th, the SANTA BARBARA found 35-kn winds and waves to 15 ft north of the Panama Canal.

A northerly oriented trough developed out of the Saharan heat LOW over Algeria late on the 18th over western Iberia. A 1014-mb LOW had formed over Lisboa by the 0000 chart of the 20th. At 1200 the LEOPOLD, at 40°N, 11.4°W, experienced 40-kn winds. The small LOW remained stationary, and at 1200 on the 21st, the MUIRFIELD found 37-kn winds near the same spot (40°N, 12.4°W). At 1800 the BUKAVU, at 42.2°N, 09.8°W, was also hit by 40-kn gales. On the 22d, no closed LOW could be analyzed.

There was a complex frontal system over the northeastern United States on the 23d and 24th which was slowly sliding south and eastward. On the 1200 chart of the 24th, what appeared to be a new LOW developed north of Maine. This LOW deepened rapidly as it moved over the Gulf of St. Lawrence, and the fronts consolidated. At 1200 on the 25th, the JOHN CABOT (44.2°N, 57.9°W) reported 39-kn gales, the SEA-LAND GALLOWAY (41.4°N, 59.9°W) had 35-kn winds with 15-ft waves, and another ship reported 40 kn with a thunderstorm near 36°N, 65°W.

On the 26th, the LOW remained stationary north of Anticosti Island with the front continuing to move eastward. Early on the 27th, it disappeared.

Tropical Cyclones--The first tropical storm of 1976 began as a subtropical system. During the latter part of July, a weak, ill-defined surface low-pressure system formed several hundred miles southeast of Bermuda. Satellite pictures showed a disorganized area of convective activity near and to the east of the apparent low-pressure center. On the 28th, the cloud pattern became sufficiently well organized to define a low-level circulation center. The system did not possess the typical appearance of a tropical depression since the main convection was displaced well to the east of the circulation center with additional convective clouds extending far to the northeast. Because of the system's appearance, size, and location of origin, it was classified as a subtropical depression. At 0200 on the 30th, the POINTE ALLEGRE passed through the center of the intensifying storm and reported a barometric fall from 1014 mb to 999 mb followed by a rapid rise to 1010 mb. Meanwhile, the ship experienced heavy thunderstorms with gusts to 60 kn and winds shifting from southeast to south-southwest to northwest. The National Hurricane Center issued a special subtropical storm advisory for marine, aviation, and military interests at 1100 on the 30th.

As the storm moved toward the east-northeast, it rapidly acquired the appearance of a tropical storm on satellite pictures and was designated tropical storm Anna at 1600 on the 30th. The storm moved on a steady east-northeasterly course at about 20 kn for the next 36 hr. The intensity, as inferred from satellite pictures, also remained steady at approximately 40 kn. As Anna crossed south of the Azores on August 1, her path was blocked by a surface ridge to the east and north. During this period the cloud pattern became disorganized, and the system lost tropical characteristics. The center became difficult to track since it was nearing the limit of GOES satellite range; however, a ship (FNXX) encountered the storm in its extratropical stage about 400 mi northeast of the Azores at 1200 on the 2d and reported easterly winds of 46 kn with a pressure of 998.5 mb. On the 3d at 1200, the MOSELSTEIN encountered 60-kn northerlies in 25-ft seas just west of Anna's center. The storm's motion continued essentially blocked for the next 3 days as it made a slow counterclockwise loop through the Azores. During this interval the system gradually weakened and eventually passed east of the Azores as a 1015-mb low on the 6th.

Casualties--The 14,396-ton POLARIS 1 dragged anchor in heavy weather on the 3d and drifted onto a reef at 12.5°N, 81.7°W. A 94-ft yacht, the THUNDERBIRD, sank in 200 ft of water in Lake Michigan on the 11th. The $1 million, 1-yr-old vessel was battered by strong winds and heavy seas. On the 12th, the 19,160-ton RALPH MISENER reported damage during a squall off Indiana Harbor on Lake Michigan. The Greek-registered 8,957-ton AEGIS FORCE arrived Havana with machinery damage resulting from bad weather. The 500-ton German SLEIPNER and the 6,600-ton Polish MARCELI NOWOTKO collided in fog near Rozewei Lighthouse on the Polish coast on the 12th.

SMOOTH LOG, AUGUST 1976--The major track of storm centers that affected shipping moved along the St. Lawrence River valley, crossed the coast over the Strait of Belle Isle, then curved more northeastward and passed over the Denmark Strait. This closely followed climatology, except the climatic path normally splits southeast of Kap Farvel to pass south of Iceland into the Norwegian Sea. This last part was not present this month nor was a secondary track across Ireland, England, and Denmark. Another major track which normally enters Baffin Bay from southern Hudson Bay was across northern Hudson Bay into Baffin Bay. A storm wandered over the Azores Islands, and another was off the coast of Portugal.

The dominant pressure feature was the Bermuda-Azores High. The monthly mean pattern shows the 1023-mb High centered near 35°N, 38°W, and two 1008-mb Lows--one over Ungava Bay and the other slightly south of Iceland. This month's mean pattern had the 1024-mb Bermuda-Azores High centered near 37°N, 45°W. Another 1024-mb center was over Scotland. The ridges that normally extend over the eastern United States and Europe were more intense than normal producing dry weather. Many areas suffered droughts of varying degrees. The primary Low was 1002 mb and centered over Home Bay on the coast of Baffin Island. A small, closed 1004-mb Low was near Angmagssalik, Greenland. An anomalous 1018-mb Low, near 39°N, 22°W, was imbedded in the Azores side of the Bermuda-Azores High.

The most significant anomaly was plus 13 mb and centered over Scotland. This had a profound effect on the rainfall over northern Europe. Some parts of the United Kingdom had the driest summer on record. The Low in the vicinity of the Azores produced a negative 4-mb anomaly. The pressure over the North Pole produced a minus 13-mb anomaly in that region. The Low over Home Bay resulted in a minus 8-mb center over Baffin Bay.

The upper-air flow at 700 mb was less zonal than usual across the water. The normal shallow trough was over the East Coast of the United States. Another trough between 35° and 40°W was produced by a High off the Bay of Biscay and a pronounced ridge over northern Europe. The significant anomaly was positive over Scotland with the pressure surface 132 m (430 ft) higher than normal.

Extratropical Cyclones--There was only one large extratropical storm this month, and it would have been unusual if there had been more. The fact that most of the circulations that did develop traveled the route between Greenland and Iceland helped hold their size to a minimum owing to the semipermanent HIGH over Greenland and the more pronounced ridge over Europe. The one large storm developed near the Azores Islands.

The first storm with gale-force winds developed almost directly over Kap Farvel at about 0000 on the 3d. The center moved up the East Coast at 990 mb. At 1800 on the 3d, the CHEVIOT, at 53.8°N, 30.7°W, had 35-kn gales with light rain. At 1200 on the 4th, the weather station on the ice cap, near 65°N, reported 40-kn winds, a buoy at 61.8°N, 29.1°W, reported minimal gales, and the MERC had 35-kn winds and 13-ft seas at 60.5°N, 25.2°W. At 0000 on the 5th, a ship near 60.5°N, 27°W, found 35-kn gales and 15-ft seas. By 0000 on the 6th, the wind at Scoresby Sound indicated the LOW was near that position, but there was no other indication of a closed circulation.

This LOW began near 56°N, 52°W, as a frontal wave on the front from the above circulation. At 1200 on the 5th, it was 992 mb just south of Kap Farvel. At 1200 on the 6th, the 984-mb LOW was at 65°N, 38°W. The buoy at 61.8°N, 29.1°W, reported 40-kn winds. The MEERKATZE II at 65.8°N, 26.5°W, off the coast of Iceland had 38-kn southerly winds and 18-ft swells. At 1800 the swells had decreased to 13 ft. The wind at the ice cap weather station was 60 kn from the northwest at 1200. The LOW continued up the Greenland coast to die over the Greenland Sea.

The northern Great Plains produced the LOW that became this storm. It developed on the 4th and raced eastward as a frontal wave with no deepening until it was over the Labrador Sea on the 7th. By 1200 it was 990 mb southeast of Kap Farvel. As it deepened, it slowed; and by 1200 on the 8th, it was 980 mb near 66°N, 29°W. The buoy near 62°N, 29°W, reported 35-kn gales. The LETCHWORTH, near 57°N, 37°W, had 40-kn gales. At 1800 the buoy reported 45-kn winds. The GLOMAR CHALLENGER (58.7°N, 25.9°W) measured 41-kn winds and 18-ft waves at 1200 on the 9th. By the 10th, the LOW was absorbed by another following it up the coast of Greenland.

This was an Arctic system that came across northern Canada. It moved across northern Hudson Bay late on the 9th and early on the 10th. As it neared the Davis Strait, its circulation expanded. At 1200 on the 10th, it was 993 mb near Frobisher Bay. At 1800 the PELICAN (66.1°N, 56.2°W) had 45-kn southeasterly winds and 13-ft waves in the Davis Strait. At 1200 on the 11th, the LOW crashed ashore on Disko Island on the coast of Greenland.

The first indication of this storm was near Windsor, Ontario, on the 15th. It tracked just north of the St. Lawrence River, and the 1000-mb center crossed the Strait of Belle Isle at 1200 on the 17th. It moved across the Labrador Sea with no gales reported. At 0000 on the 19th, the 994-mb center was near 60°N, 25°W. The SEGESHA, at 46.9°N, 36.4°W, was east of the front at 0600 with 42-kn winds. At 1200 the AUENDBORG, at 65°N, 38°W, suffered 44-kn winds at 2°C.

On the 20th, the LOW looped westward back to the coast of Greenland prior to turning eastward and then northeastward again. The LOW continued northeastward and was over Spitsbergen on the 24th.

A cold front moved into the circulation of hurricane Candice on the 24th, and by the 25th the tropical cyclone was extratropical. Frontal waves were forming on the front and moving northward. At 1800 on the 27th, the JEAN LYKES at 44.5°N, 40.9°W, found only 35-kn winds, but the waves were 17 ft. On the 0000 chart of the 28th, a new frontal wave formed near 43°N, 31°W. The surface LOW moved slightly northward as an upper-air LOW rapidly retrograded westward from near Lisbon. By 0000 on the 29th, they were stacked vertically near 42°N, 32°W.

At 1200 on the 28th, the first gales were observed. Forty-four knot winds from the northwest were reported by the BREMERHAVEN (42.7°N, 32.4°W) and the MASON LYKES (38.5°N, 30.5°W). The highest seas were 13 ft. At 0000 on the 29th, the STRATHANGUS, at 41.2°N, 37.5°W, observed 52-kn winds, 16-ft seas, and 23-ft swells about 250 mi west of the 997-mb center. The PIONEER CRUSADER at 46.5°N, 37.7°W, had 38-kn gales, 12-ft seas, and 33-ft swells. The ECUADORIAN REEFER fought 13-ft seas and 20-ft swells near 38°N, 35°W, at 1200. At 1800 the STRATHANGUS had 37-kn winds with 21-ft swells. Many ships were observing thunderstorms.

The LOW moved southward on the 29th and 30th. On the 31st, it began moving eastward as hurricane Emmy moved eastward. At 1200 Emmy was about 800 mi west of the 1002-mb storm near 37°N, 28°W. The STEINFELS reported 45-kn winds about 300 mi south of the LOW. On September 1, the LOW was filling as Emmy was approaching from the west and absorbing the circulation of the system. At 1800 a SHIP at 39°N, 23°W, reported 60-kn winds from the east. At 0600 on the 2d, the LOW could still be identified, but Emmy was dominating the circulation. The FROSTFJORD was north of the center at 40.7°N, 19.5°W, with 40-kn easterly winds. After 1200 Emmy completed her takeover as hurricane Frances followed to the west-southwest.

The plains area of Canada west of Lake Winnipeg was under the influence of a weak meteorological system on the 25th. By midday on the 26th, the weather had consolidated, and a major LOW formed near 55°N, 111°W. The storm's center moved eastward, and by 1200 on the 27th, it was 993 mb near 55°N, 102°W. By now, the southerly winds ahead of the front were influencing the Great Lakes. At 1800 the WILLIS B. BOYER on central Lake Superior measured 46-kn winds from 190°. Early on the 28th, the G. M. HUMPHREY at nearly the same location measured 39 kn.

After the cold front moved across the lake, the winds shifted to westerly, and the WILLIS B. BOYER and SAMUEL MATHER were on the eastern end of Lake Superior with 42- and 40-kn winds, respectively. Both found the seas to be 10 ft.

The LOW moved northeastward after crossing southern Hudson Bay. The eastern edge of the storm extended over the Labrador Sea but did not affect any shipping. On the 30th the LOW was traveling northward over Baffin Bay.

Tropical Cyclones--The precursor of Belle moved westward off the African coast on July 28. It was the 20th tropical system of 1976 to be tracked across the Atlantic and was quite well defined.

The wave traveled across the Atlantic at a little more than 20 kn. While the wave itself continued westward across the Caribbean, the major convection separated just east of the Leeward Islands and moved northwestward and slowed down, reaching a position just east of the northern Bahamas on August 5.

Early on the 6th, the surface circulation was sufficiently well defined to upgrade the system to a tropical depression with maximum surface winds of 25 kn and a minimum central pressure of 1012 mb. Intensification was rather steady from the 6th through early on the 9th when the minimum central pressure was determined to be 957 mb and the maximum sustained windspeed was estimated at 105 kn. Belle was upgraded to tropical storm status on the evening of the 6th and to a full hurricane during late afternoon on the 7th. The hurricane classification was based on reports from reconnaissance aircraft as well as the fact that an eye was detected from satellite photographs. The CARNIVALE encountered 40-kn winds some 200 mi west of the center at 0000 on the 8th.

While Belle was a tropical depression and for the first few hours as a tropical storm, her position remained about 250 mi east-northeast of Nassau in the Bahamas. Actually, during this time, she was moving in a small cyclonic loop. Soon after reaching tropical storm intensity, she accelerated toward the northeast, and on the 8th she started moving northward. This direction of motion continued for the next 2 days during which time her forward speed increased to between 20 and 25 kn. Belle's eye passed very near

Figure 23.--This debris was washed up near the Steel Pier and Boardwalk at Atlantic City, N.J., by hurricane Belle. Wide World Photo.

Table 8.--From Ship's Log, AMOCO VIRGINIA

Aug. 76	Time	Wx	Wind	Sea	Swell	Pres.	Temp.
	Drifting						
8 (M)	2400	--	SE 3	SL		3001	71
	Anchored						
9	0400	C	SE 3	SL	SSE M	2998	72
	0800	--	NE 3	NE SL	S M	2994	72
	1200	P	NNE 4	NNE M	S M	2984	72
	1300	R	N 4-5	N R	N M	2977	71
	1400	R	N 5-6	N R	N H	2964	70
	1500	R	N 7-8	N R	N H	2957	69
	1600	R	NNW 12	NNW R	N VH	2945	68
	1700	RS	NW 12	NW H	NNW VH	2939	68
	1800	RS	WNW 12	NW VR	NW H	2945	68
	1900	RS	W 11	NW VR	NW H	2953	69
	2000	RM	W 9	WNW VR	WNW VR	2962	70
	2100	RM	W 9	WNW VR	WNW VR	2976	70
	2200		WSW 8	WSW VR	WSW VR	2980	70
	2300		SW 7	SW VR	SW VR	2989	70
	2400		SSW 7	SSW R	SSW R	2991	70
10	0100	C	SW 3-4	SW M	SW M	2998	70

buoy EB15 (32.3°N, 75.3°W) about 0600 on the 9th. At that time the winds were 60 kn from 230° with a pressure of 965.2 mb, and the waves were 23 ft. At 0300 the readout was 55 kn/060°, 995.9 mb, and 20 ft and at 0900, 47 kn/270°, 998.8 mb, and 13 ft.

Late on the 8th, the 12,532 gross ton tanker AMOCO VIRGINIA became disabled off Assateague Island owing to loss of water to the boilers. She set two anchors in 40 ft of water and rode out the storm while waiting a tug. The roughest weather (table 8) was between 1500 and 2000 on the 9th. The ship reported weather and sea conditions to the Coast Guard at Chincoteague every half hour. At 0000 on the 10th, Belle passed near EB41 which recorded 36-kn winds and 25-ft seas. At the same time OWS Hotel, 150 mi southeast of the center, encountered 45-kn winds in 22-ft seas. She was pounding the east coast with high winds and surf (fig. 23).

Belle made landfall at 0500 on the 10th on the south coast of Long Island in the vicinity of Jones Beach. She moved northward across Long Island, then over Long Island Sound, and reached the Connecticut coast near Bridgeport. Her course continued across west-central Massachusetts into southwest New Hampshire and, finally, northeastward into western Maine. During this later period, over New Hampshire and Maine, tropical characteristics were lost.

Estimates of damage caused by strong winds are minimal. Maximum sustained winds reported were less than hurricane force over most of the warning area. Steady 55- to 65-kn northwesterly winds were estimated along the Outer Banks of North Carolina as Belle passed just offshore. As she moved northward, the next highest wind reported was 50 kn with gusts to 60 kn at Ocean City, Md. Along the New Jersey coast, 30- to 40-kn winds were common, but Ship Bottom estimated 55-kn winds gusting to 80 kn, and Manasquan estimated 70-kn gusts. LaGuardia Airport in New York City measured 52-kn northeasterly winds with gusts to 63 kn. Sustained winds of 55 kn were common on the southern shore of Long Island, and an estimated gust to 80 kn was reported from Jones Beach. Finally, as the storm moved across southern New England, there were several instances of gusts above hurricane force, but steady winds were mainly in the 30- to 40-kn range.

Tides associated with the storm surge were generally about 3 ft above normal along much of the coast. However, at some locations from New Jersey southward, tides were somewhat below normal due to an offshore wind component. At Ocean City, Md., estimates of 4 ft above normal were reported. Battery Park at the southern tip of Manhattan had tides 7.2 ft above MLW or 4.5 ft above normal. No figures have been received from Long Island where it is suspected that some higher tides may have occurred.

Rainfall amounts of 4 to 5 in during the 24-hr period of Belle's passage were common over much of the warning area as well as quite a distance inland, especially in the western and northern mountains of New England.

Because of widespread precipitation throughout the area for a day or two immediately prior to the hurricane, there was considerable flooding of small streams and roads. Crop damage was spotty, and although there were some losses to bottomland crops, the New England Crop and Livestock Reporting Service said, "Damage from Hurricane Belle was much less then anticipated. . ."

There were five storm-related deaths which possibly may be attributed to Belle. In New England, two drowned in southern Vermont when a foot bridge was swept from under them, and in Connecticut a woman was killed in Barkhamstead when her car skidded into a tree. A traffic accident in heavy rain resulted in one death in Norfolk, Va. In New York a falling tree was responsible for one fatality.

It is estimated that nearly one-half million people were evacuated in anticipation of the danger of Belle's storm surge. Available evacuation figures include 250,000 people along the New Jersey shore, 30,000 people in New York City and Suffolk County, N.Y., 5,000 in Connecticut, and 10,000 on the North Carolina coast, as well as unknown thousands elsewhere in New England and along the Eastern Seaboard.

Hurricane Candice had its origin in a baroclinic system. On August 11, a cold Low was clearly evident at 200 mb, but it was not until the 16th that a broad low-pressure area could be drawn on surface charts. The surface Low began to organize, and at 1200 it was classified as a depression, centered near 32°N, 68°W. Satellite pictures showed increasingly better organization, and a ship reported winds gusting to 40 kn. Development continued, and the storm was named at 2200 on the 18th.

As the storm moved northwestward at 15 kn, slight weakening occurred on the afternoon of the 19th and continued until the following afternoon when the storm again began to deepen. Candice became a hurricane during the night of the 20th. The MANCHESTER VIGOUR, 150 mi southwest of the center, encountered 50-kn winds in 20-ft swells late on the 20th. Twenty-four hours later, the BAKAR ran into 45-kn winds amidst 33-ft seas. Maximum intensity was reached on the afternoon of the 22d when the lowest pressure dropped to 964 mb and maximum sustained winds climbed to 80 kn. Early on the 24th, the hurricane was overtaken by a rapidly moving cold front east of Cape Race, Newfoundland. It lost its identity as a tropical system rapidly while accelerating northeastward over the open Atlantic.

Dottie began spectacularly and ended ignominiously. The initial low center formed about 150 mi northwest of Key West during the evening of the 17th in response

to a strong upper-level trough which moved rapidly southward into the eastern Gulf of Mexico. By morning on the 18th, the center consolidated between Dry Tortugas and Key West as pressures fell 8 mb in 24 hr in the area. The depression drifted slowly eastward and then northeastward during the next 24 hr with the pressure falling to 1004 mb at Key West by early morning on the 19th.

The system moved rapidly northeastward during the morning of the 19th, and it was named tropical storm Dottie that afternoon as it reached the Atlantic near Palm Beach. Air Force reconnaissance reports indicated 35-kn winds near the middle Keys around midmorning and 35- to 45-kn gusts in the middle and upper Keys and on Grand Bahama during the day. In addition, 24-hr rainfall amounts of 5 in were common in the greater Miami area with one report of over 8 in in Coral Gables.

Building high pressure north of the storm indicated Dottie would turn more to the west. Also, conditions appeared favorable for further strengthening. Dottie intensified after moving offshore, and an Air Force plane found the storm's minimum central pressure of 996 mb and maximum estimated surface winds of 45 kn around 0600 when the center was about 75 mi east-northeast of Daytona Beach. Strong high-level winds over the storm caused weakening thereafter, and Dottie was barely tropical storm strength at landfall. Gusts of 35 to 40 kn were reported at beach locations near Wilmington, N.C. Tides were 3.5 ft above normal at Atlantic Beach, N.C., and ranged from 1 to 2 ft above normal from Jacksonville Beach to the North Carolina Outer Banks. Carolina Beach, N.C., had a storm rainfall of 7.78 in with 4 to 6 in over coastal North Carolina near Wilmington.

Four deaths resulted when a fishing boat sank on the 19th near Grand Bahama Bank. Damage from the storm was minor, occurring mainly as beach erosion from Georgia to North Carolina.

The disturbance that spawned Emmy moved off the African coast on the 15th. On the 20th, the westward-moving system organized into a tropical depression about 1,000 mi east of the Windward Islands. Development continued, and tropical storm Emmy was christened on the 22d. Emmy turned northwestward. On the 24th, after reaching hurricane strength near 25°N, 65°W, she was pushed eastward by an unseasonal frontal LOW in the mid-Atlantic. She gradually returned to a more northerly course and continued to intensify. A strong blocking ridge over the North Atlantic produced an anomalous westerly flow across the mid-Atlantic near 35°N and caused Emmy to turn eastward again when she reached this latitude on the 28th. The MIR, 60 mi northeast of the center, ran into 55-kn winds that same day.

The MARABOU, a 1,962-ton Greek vessel with a crew of 22, became disabled and trapped in Emmy on the 26th. Reports indicated she was unable to steer owing to the high winds and was in danger of stopping because of a crack in the engine exhaust chain. An Air Force C-130 hurricane hunter arrived on the scene to act as a communication relay. A Navy P-3 Orion relieved the C-130. The AMERSFOORT diverted to assist. On the 27th the MARABOU radioed that no further assistance was required as they had the situation under control and the rescue units were released.

At this time Frances was developing in the same area where Emmy was christened. As Emmy was peaking on the 29th, Frances reached hurricane strength on a northwestward track with winds of 90 kn around a 974-mb central pressure. Frances turned northward on the 30th, while Emmy continued eastward along the 35th parallel.

On the 31st, the DIOGENES, 120 mi east of Frances' center, battled 35-kn winds in 20-ft swells, while the GUAVACORE, 60 mi northeast of Emmy, rolled in 25-ft seas and 20-ft swells. Frances continued to close the gap between the two storms as she reached maximum intensity from the 1st through the 4th. Winds near her center, whose pressure had dropped to 963 mb on the 1st, blew at 85 kn. Meanwhile, Emmy slowed and turned northward on the 1st and 2d. She passed over the central Azores on the 3d as Frances was crossing the 30th parallel near 38°W. A Venezuelan Air Force plane, carrying a school choir to Europe, crashed while attempting to land at Lajes Air Force Base in the Azores at the height of the storm. Sixty-eight people were killed.

Frances moved through the Azores on the 5th after absorbing Emmy into her large circulation. However, she was beginning to weaken and turn extratropical. The following day she completed this transformation near 43.5°N, 27°W.

Casualties--The SEMANG PONTOON arrived Trinidad with heavy weather damage sustained on a voyage from San Francisco to Georgetown, Guyana.

Smooth Log, North Pacific Weather

July and August 1976

SMOOTH LOG, JULY 1976--The general trend of the storm tracks this month was more easterly than long-term climatology indicates, except in the Gulf of Alaska area. A climatic secondary track across Sakhalin Island into the Bering Sea was a primary track this month. The normal climatic path originating near Japan was approximately 5° latitude farther south and traced a path easterly toward the Gulf of Alaska, rather than northeasterly into the Bering Sea.

The predominant pressure feature was the Pacific High at 1026 mb, centered near 33°N, 165°W. The climatic location is normally 39°N, 150°W, at 1025 mb. There were two anomalous low-pressure centers, a 1006 mb near 54°N, 179°E, and a 1012 mb near 52°N, 142°W. The climatic mean pressure pattern does not indicate a low-pressure center over the North Pacific. A 1010-mb center is almost directly over the North Pole, and there is a large cyclonic

circulation over the Asian Continent.

There were two significant negative anomaly centers, both 7 mb, near 55°N, 177°W, and 50°N, 140°W. There was an irregular area of positive anomaly approximately 10° latitude wide that stretched from the Yellow Sea to 30°N, 160°W.

The primary feature of the 700-mb pressure height chart was the zonal flow between latitudes 40° and 50°N. The mean Pacific High was higher than normal, and the anomalous surface LOWs were reflected in an anomalous LOW at 700 mb over the central Bering Sea. The primary mean cyclonic circulation center was still over the Arctic Ocean.

There were eight tropical cyclones over the North Pacific, four for each hemisphere. Over the eastern ocean there were three tropical storms (Celeste, Estelle, and Fernanda) and hurricane Diana. Over the western ocean there were typhoons Therese and Anita and tropical storms Violet and Wilda.

Extratropical Cyclones--The extratropical part of typhoon Sally, which originated in June and extended into July, would have to be the "Monster of the Month." This LOW originated near 48°N, 177°E, northeast of typhoon Sally, on the 2d. By 1200 on the 4th, the LOW was 994 mb near 48°N, 150°W. The PAPYRUS MARU, at 40.9°N, 151.4°W, had 32-kn gales and 13-ft waves. Twelve hours later, the CHEVRON FRANKFURT reported 35 kn near 38°N, 153°W. Late on the 5th, the storm turned northward and on the 6th westward. At 0600 winds of 40 kn were radioed by the ORIENTAL AMIGA near 48°N, 126°W, and the SUN BOWL also had 40-kn gales near 54°N, 147°W. At 1200 the PRESIDENT MADISON found 40-kn winds and 12-ft seas near 43°N, 147°W.

Late on the 7th, the storm again turned eastward, and the UGOU was hit by 44-kn gales. At 0600 the PRESIDENT MADISON (43.7°N, 150.5°W) did not mind the 35-kn winds as much as the 15-ft waves. On the 8th, the BREWSTER reported 40-kn winds twice on her eastern course. On the 8th, the storm curved northward again, only to turn back toward the south on the 9th, and dissipate on the 10th.

This storm formed over the Kuril Islands, east of a LOW that had moved out of Manchuria, in an area of weak gradient on the 12th. A warm front extended eastward to another LOW over the Aleutian Islands. At 1200 it was 1002 mb near 51°N, 160°E. At 0000 on the 13th, the JAMSONS was at 45.7°N, 163.8°E, with 44-kn gales. At 0000 on the 14th, the VULCAN, near 48°N, 172°E, received 40-kn gales at frontal passage, and a ship identified only as URI was on the receiving end of 46-kn winds near 53°N, 159°E. At this time, the LOW was about 996 mb near 54°N, 165°E. The LOW was moving eastward very slowly and started filling. By the 18th, it no longer existed.

This LOW started as a frontal wave, late on the 14th, south of another LOW over the Gulf of Alaska. It rapidly became the major system. A ship found 40-kn gales near 47.5°N, 139°W. By 0000 on the 16th, it was 992 mb near 53°N, 142°W. The GYOKUYO MARU was south of the center with 40-kn gales. Other ships were reporting 10-ft seas. At 0000 on the 17th, the LOW was 998 mb, and the pressure had risen to 1014 mb by 0000 on the 18th.

On the 16th, a front stretched all the way across the North Pacific from Seattle to Tokyo. There were several frontal waves and small LOWs along the front. On the 17th one of these continued to develop into a major circulation as it moved eastward. At 1200 and 1800 on the 18th, the THOMAS E. CUFFE found 35-kn gales near 41°N, 141°W. The seas were about 8 ft. By 0000 on the 19th, the LOW was near 48°N, 138°W, at 1002 mb. The ALMIZAR was north of the center at 50°N with 40-kn northeasterly winds and 13-ft seas. The PROFESSOR DERYUGIN was about 200 mi west of the center with 40 kn and 20-ft seas. The VAN CONQUEROR measured 37-kn winds at 1200, 225 mi southwest of the LOW.

On the 20th, the LOW was pushing against the Pacific coast. The CHEVRON WASHINGTON was being bounced by 13-ft seas from the northwest and 15-ft swells from the north. On the 21st the LOW disintegrated on the rocky coast.

This was one of the long-lived circulations. It started as a frontal wave east of Tokyo near 147°E. It moved generally eastward as a 1016-mb wave. It managed to survive cutting off a segment of the Pacific High and moved into the eastward flow on the 22d. By the 23d, it was still only 1004 mb near 49°N, 164°W.

At 0000 on the 24th, the EASTERN BUILDER was southwest of the center, near 43°N, 158°W, with 45-kn westerly winds, but only 8-ft waves. At 0600 the JUNEAU MARU was north of the center with 35-kn easterly winds. At 1200 on the 25th, the LOW was 1002 mb near 54°N, 144°W. At 1800 the HILLYER BROWN, near 51.5°N, 138°W, had 35-kn gales and 13-ft swells. At 0000 on the 26th, the LOW was weakening, but the GRAND CARRIER, near 49°N, 140°W, managed 35-kn gales. By the 27th, the LOW had broken up on the coast.

This was the deepest extratropical storm to affect the North Pacific this month. It started over the Tatar Strait on the 24th. When it moved over the Kuril Trench on the 25th, it started deepening. At 1200 on the 26th, it was 982 mb, near 54°N, 174°E, but the winds were still in the 20-kn category. At 0000 on the 27th, the pressure had dropped to 978 mb, and now the KONSANTIN PAUSTOVSKI, near 53°N, 173°E, had 45-kn winds and 16-ft seas. A ship east of the center and north of the Aleutians reported heavy rain and 16-ft swells.

At 1200 on the 27th, the LOW was at its lowest pressure of 976 mb near 53.5°N, 177°W. Its cyclonic circulation stretched from the Bering Strait south to near 35°N. At 0000 on the 28th, the LENINETS was about 300 mi southwest of the center with 40-kn winds and 20-ft seas. In the southeast quadrant, near 51°N, 168°W, a Japanese ship reported 16-ft seas and 20-ft swells.

At this time, the LOW was headed northward over the Bering Sea and filling. At 0000 on the 29th, the TIRASPOL (55°N, 167°W) contended with 34-kn winds and 13-ft seas. By the 30th, the LOW had deteriorated to only a trough.

Tropical Cyclones, Eastern Pacific--Celeste and Diana developed within 1 day and 450 mi of each other. Both formed near 11°N--Celeste at 108°W on the 14th, and Diana at about 102°W a day later. Celeste took a

westward track and became a tropical storm. Diana moved west-northwestward and reached hurricane strength. Celeste's winds reached 45 kn on the 16th, while Diana attained an 80-kn peak on the 19th. Both peaks occurred at about 120°W about 250 mi apart. While Diana was reaching her peak, Celeste was dissipating as she crossed the 140th meridian near 13°N. When Diana reached that same meridian, near 19°N on the 22d, she was also on the wane.

Toward the end of the month, two weak tropical storms flared briefly in the eastern Pacific. Both developed at about 12°N and moved west-northwestward. Estelle formed near 122°W on the 26th, while Fernanda was found about 700 mi farther west on the 28th. It appears that maximum winds in neither storm climbed above 35 kn. Both lasted as depressions through August 1; Fernanda moved within 200 mi of the Hawaiian Islands.

Tropical Cyclones, Western Pacific--Therese developed rapidly. She reached typhoon strength, on the 12th, about 150 mi north of Truk and was a supertyphoon the following day. For a while she threatened Guam, which was still recovering from the blow dealt by supertyphoon Pamela in May. However, Therese turned northwestward and brought her fury to Saipan instead. Winds near her center were estimated at 135 kn on the 13th. Although Therese's intensity diminished somewhat on the 14th, she remained potent as she moved northwestward toward the Ryukyu Islands. On the 15th, the JESSIE STOVE, 150 mi west of her center, encountered 45-kn winds. Minami-daito jima reported 50-kn winds on the 17th as Therese moved through the central Ryukyu's. Winds were still at typhoon strength when Therese made landfall on the 19th over western Kyushu near Sasebo.

Less than one week later, tropical storm Wilda and typhoon Anita came ashore on the eastern side of Kyushu. Wilda developed near 20°N, 137.5°E, on the 22d, while Anita was spotted near 19°N, 134°E. They both moved in a northerly direction. Early on the 23d, Wilda's winds peaked at about 50 kn, while Anita briefly attained typhoon strength late in the day. Both were tropical storms when they moved across eastern Kyushu, Wilda late on the 23d and Anita about 24 hr later.

While Japan was suffering from this flurry of activity, tropical storm Violet was on the loose in the East China Sea. She developed on the 21st near 15°N, 116°E. Violet headed northwestward and encountered Hainan before her winds could climb above 55 kn. On the 24th, the tropical storm moved northeastward back out to sea. Carrying winds of 40 kn, Violet moved over mainland China near Yang chiang on the 25th.

Casualties--During the early morning of the 8th, the 977-ton ORENJI MARU and the 498-ton NAGATO MARU No. 31 collided in heavy fog on the Inland Sea. The 23,486-ton AUSTRALIAN EXPORTER reported damage to a crane during a storm on July 10. A hovercraft reported to be traveling at 50 mi/h across Beppu Bay in fog collided with the 200-ton bulkcarrier KOSEI MARU on the 14th. Twenty-five persons were injured. The hovercraft capsized, but all escaped.

On the 18th, the DIAMOND M. NUGGETT, a drilling rig, lost its anchor during strong winds at Salvador and grounded.

Cargo shifted in heavy weather on the 25th near 8°N, 53°E, causing damage and flooding to the No. 2 hold of the 10,150-ton TONG SING. The 18,064-ton CRETAN STAR encountered heavy weather and was struck by a high wave 450 mi off Bombay on the 28th. Deck plating and a tank was damaged with engineroom taking water. An air and sea search was conducted for the vessel and crew of 36.

SMOOTH LOG, AUGUST 1976--There are three primary climatological extratropical storm tracks this month. North to south, they are: Mys Lopatka to the Bering Strait, northern Honshu to the Pribilof Islands, and from south of the Alaska Peninsula into the Gulf of Alaska. Although the actual tracks this month were not concentrated, two primary tracks were apparent. One extended from Honshu to Nunivak Island and the other from the north-central ocean into the Gulf of Alaska. One odd storm wandered southward off the coast near the Queen Charlotte Islands to southern California.

The mean pressure pattern for the month closely matched the climatological mean. The most prominent feature was the Pacific High at 1025 mb near 38°N, 156°W, versus 1024 mb near 39°N, 150°W, according to climatology. There were two Low centers--1007 mb near 56°N, 176°E, and 1010 mb near 59°N, 160°W--versus only one 1008-mb center near 60°N, 175°E, on the climatological chart.

Since the climatological mean and the monthly mean closely matched, the anomalies were small. The negative 13-mb center near the North Pole did not appear to influence the North Pacific. There were two negative 3-mb centers--the largest near 56°N, 177°E, and the other at 54°N, 150°W. There were an elongated area of plus 3 mb off Baja California and a positive 4-mb center south of Japan.

Between latitudes 40° and 50°N, the upper-air wind flow was mainly zonal from coast to coast. A Low and trough, rather than trough, were over the Bering Sea with the High centered near 35°N, 160°W, near its climatological position, but the height was slightly higher at 700 mb. A much sharper trough paralleled the North American coast than is indicated by climatology.

There were four tropical cyclones over the eastern ocean--tropical storms Gwen and Joanne and hurricanes Hyacinth and Iva. In the western Pacific, tropical activity started with a bang with supertyphoon Billie but slowed down after that with three tropical storms--Clara, Dot, and Ellen.

Extratropical Cyclones--The first cyclone to affect shipping during the month formed as a wave on a cold front in the southern part of the Sea of Japan early on the 3d. It moved rapidly eastward and by 1200 was off the east coast of Honshu just northeast of Tokyo. Shipping began to feel its sting as the 998-mb LOW moved northeastward to 40.5°N, 150.5°E, at 0000 on the 4th. In the warm sector near 39.5°N, 153.6°E, the HONG KONG PHOENIX found 40-kn southerly winds and 13-ft seas and swells. Six hours later, bracketing the warm front, the MINETAMA MARU encountered south-southwesterlies of 38 kn near 41.2°N, 155.3°E, and the YUGOH MARU fought 40-kn northerlies at 42.9°N, 153.5°E. The storm continued to move northeastward, and by 1200 on the

4th, the 990-mb LOW was centered near 44°N, 156°E. About 60 mi east of the center, the YUGOH MARU continued to report 40-kn winds, but they had backed to the northwest. A few miles to the north the LAUREL fought northerly winds of 43 kn.

On the 5th the LOW slowed its northeastward movement and began to fill. By 1200 on the 5th, it was near 48°N, 168°E, and beginning to drift toward the northwest. No gale winds were encountered close to the center as the LOW merged with the cyclone that had preceded it on the 6th.

Isolated gales of 48 kn were reported in the preceding LOW by the SUN BOWL on the 4th near 48.4°N, 179°E.

This storm, from its humble beginnings off the east coast of Korea on the 9th, managed to traverse the Pacific, made landfall at Cape Romanzof, Alaska, on the 14th, and died in the Gulf of Alaska on the 15th. Most of its effects on shipping occurred in the western ocean on the 11th and 12th.

The LOW moved east-northeasterly over the Sea of Japan and crossed northern Honshu late on the 9th. By 1200 on the 10th, the 986-mb LOW was near 42°N, 151°E, and ships were beginning to encounter gales. The OJI MARU, just north of the occluded front and 60 mi northeast of the center, was fighting 15-ft seas and 20-ft swells with 34-kn east-northeasterly winds. About 150 mi southwest of the center, the AKAISHI MARU reported 45-kn winds and 15-ft swells. The storm was now moving eastward and deepening. At 0000 on the 11th, the 983-mb LOW was near 41°N, 158°E, and gales were reported in all quadrants. The JAMSONS fought 56-kn northerlies about 300 mi west of the center, while the H3VX had its problems with 45-kn easterlies. The LAUREL at 42.7°N, 157.7°E, measured only 37-kn winds, but the seas were 20 ft and the swells 25 ft. By 0600 two ships in the southern quadrant were reporting 40- to 43-kn winds. The HAKONE MARU with the higher wind was also experiencing the higher swells (26 ft) near 37.4°N, 157.1°E, while the TAIKO MARU was facing 15-ft swells near 38.5°N, 155.2°E.

There were no further reports of gales until early on the 12th when the northeastward-moving storm was near 43°N, 166°E. The A8ZG was stung by 40-kn northerly winds in a rain shower about 100 mi west of the center. Swells were 15 ft. With the LOW increasing the speed of its northeasterly advance, it reached 47°N, 171°E, by 1200 on the 12th. At that time the BREWSTER, 200 mi south of the center, recorded westerly winds of 40 kn. The EHIME MARU was riding 16-ft swells near 42.6°N, 162.9°E.

The weakening storm entered the Bering Sea near the Rat Islands early on the 13th. As the LOW approached Nunivak Island at 0000 on the 14th, a SHIP reported 40-kn westerlies about 550 mi south of the center near 47.8°N, 178.8°W. At 1200 the storm made landfall, then drifted southeastward into the Gulf of Alaska, and dissipated on the 15th.

This LOW developed as an eastward-moving wave near Chi-lin, China, on the 19th. It moved into the Sea of Japan just north of Vladivostok early on the 20th. By the 21st it had crossed Hokkaido to 44°N, 150°E, by 1200. The storm then tracked northeastward and entered the Bering Sea near Attu Island on the 23d. At this point it started to deepen and reached a minimum pressure of 980 mb near 57°N, 180°, at 0000 on the 25th. Gales were encountered south of the center. The WORLD COMMANDER ran into 45-kn southwesterlies near 53.8°N, 177.8°W, while the ALASKAN MAIL was moving along with 44-kn westerlies.

A secondary development occurred about 750 mi southeast of the original LOW on the 24th. This LOW moved northeastward, south of the Aleutians, into the Gulf of Alaska and by the 26th was the dominant circulation. Throughout the 26th gale winds were reported by ships caught in the circulation. At 0000 on that date, the AKAISHI MARU (47.6°N, 154.9°W) struggled with 25-ft swells, 16-ft seas, and 41-kn westerly winds; the BEISHU MARU (50.5°N, 155.2°W) hit winds from the west-southwest of 40 kn; the SUN BOWL (52.5°N, 169.6°W) encountered west-southwesterlies at 46 kn. North of the 978-mb center, near 50°N, 150°W, the IDAHO STANDARD reported 40-kn easterlies with 13-ft seas and swells at 1200. The ship continued to encounter these winds at 1800. Also north of the center at 1800, the USCGC SWEETBRIER battled 33-ft swells and 45-kn easterly winds, while the ALEUTIAN DEVELOPER measured winds of 70 kn from the east-northeast with seas of 10 ft and 20-ft swells. The storm then filled off Kodiak Island on the 27th and 28th.

Tropical Cyclones, Eastern Pacific--Gwen and Hyacinth formed one day apart within 500 mi of each other. Gwen was spotted on the 5th near 107°W heading westward along the 10th parallel. Hyacinth turned up the next day farther eastward. Gwen reached tropical storm strength with maximum winds of 55 kn on the 8th. Two days later near 125°W she turned northward. Meanwhile, Hyacinth, heading west-northwestward, found conditions more favorable and reached hurricane intensity on the 9th as she crossed the 110th meridian near 15°N. Her maximum winds climbed to 100 kn on the 11th. Hyacinth began to weaken and turn toward the west-southwest, while Gwen turned northwestward. By the 14th, the two depressions merged near 20°N, 140°W.

Some 250 mi south-southeast of Acapulco, Iva sprung to life on the 24th. Travelling westward, then west-northwestward, she reached tropical storm strength on the 25th. The following day she was a raging hurricane near 15°N, 108°W. She continued to strengthen. On the 28th she passed by the Islas Revillagigedo generating 115-kn winds near her center and gales out 140 mi. This same day Joanne was coming around near 7°N, 90°W. Iva remained a hurricane until the 30th after crossing the 20th parallel near 120°W. By this time Joanne had reached tropical storm strength east of Clipperton Island. Iva was on the wane, and by September 1 she was falling apart near 25°N, 130°W. Joanne was fluctuating between depression and tropical storm strength; she finally lost the battle on the 5th near 14°N, 117°W. However, she lingered as a westward-moving depression until the 8th when she passed the 125th meridian near 13°N.

Tropical Cyclones, Western Pacific--Supertyphoon Billie began life on the 3d some 200 mi north of Saipan. She passed over the island on the 4th as a tropical storm and then headed northwestward. On the 5th the SEALIFT CARIBBEAN, some 200 mi southwest of

the center, ran into 35-kn southwesterlies. The following day Billie reached typhoon strength near 17°N, 140°E. Intensifying as she moved west-northwestward, she reached supertyphoon intensity (130 kn) for a few hours on the 7th. On the 8th, the AUSTRALIA MARU, 120 mi southwest of Billie's center, observed 40-kn winds in 15-ft swells. The following day Billie, packing 100-kn winds, crashed into northern Taiwan and rebounded into the Formosa Strait. Before entering mainland China, south of Fuchou, Billie blasted the SEALANDIA with 56-kn winds about 250 mi to the south-southeast. In Keelung, the drill ship WODECO VIII broke loose during typhoon Billie and suffered damage to its bow and starboard propellers.

While Billie was plying the western Pacific, Clara flared up about 120 mi south of Hong Kong and then died down. Stunted by the Asian mainland, she reached only tropical storm strength (40 kn) before moving inland on a northwesterly track. Her total life lasted from the 5th through the 7th.

Things were slow until the 18th when Dot arrived near 23°N, 134°E. Within 2 days the Pacific spawned Ellen near 14°N, 132°E. Both moved west-northwestward, but neither reached typhoon strength. Tropical storm Dot's winds peaked at about 50 kn on the 20th as she passed close to Naha, Okinawa, on her way to the East China Sea. Here she recurved, brushed Shanghai on the 21st, and finally moved inland over South Korea the following day. The 19,498-ton MOUNT NAVIGATOR went aground near Pusan on the 20th. On the 21st because of Dot the fore part settled and pounded on the rocky bottom. The ship's bottom was cracked and holed with several tanks fractured. The vessel was finally refloated with the assistance of the tug KOYO MARU.

Tropical storm Ellen remained on a west-northwesterly course as she moved across northern Luzon and into the South China Sea by the 23d. Her winds also peaked at about 50 kn that same day as she turned northwestward. The KIMI MARU encountered 40-kn winds some 200 mi to the south. On the 24th Ellen came ashore just east of Hong Kong.

Casualties--The Cypriot CRETAN STAR has not been heard from since being struck by a large wave during heavy weather off Bombay, India. Disabled from an engineroom fire, the 120,700-ton German tanker NIEDERSACHEN was drifting in force 7 to 8 winds about 300 mi east of Africa in the Indian Ocean on August 25.

THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

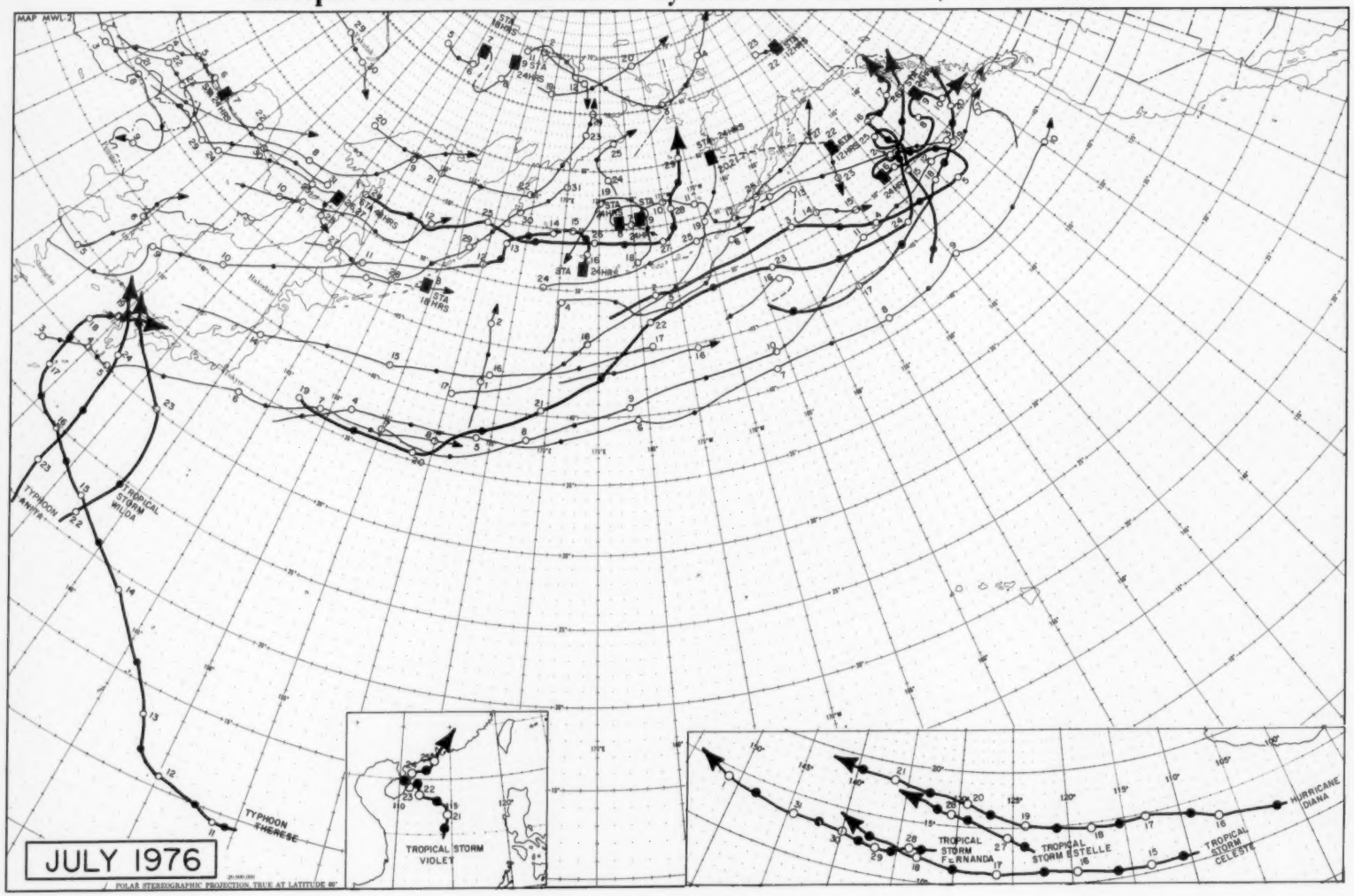

Figure 24. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

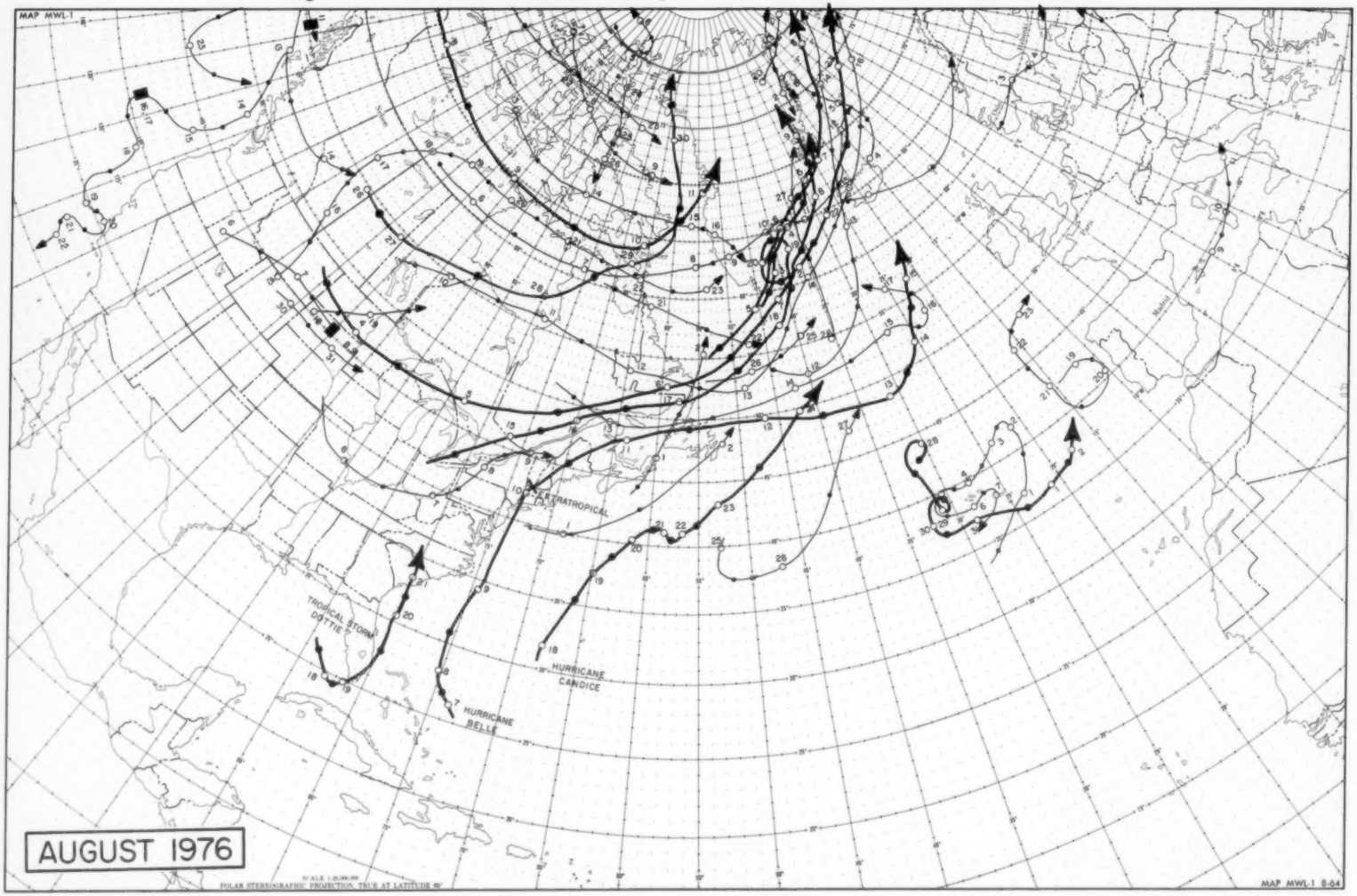

Figure 25. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

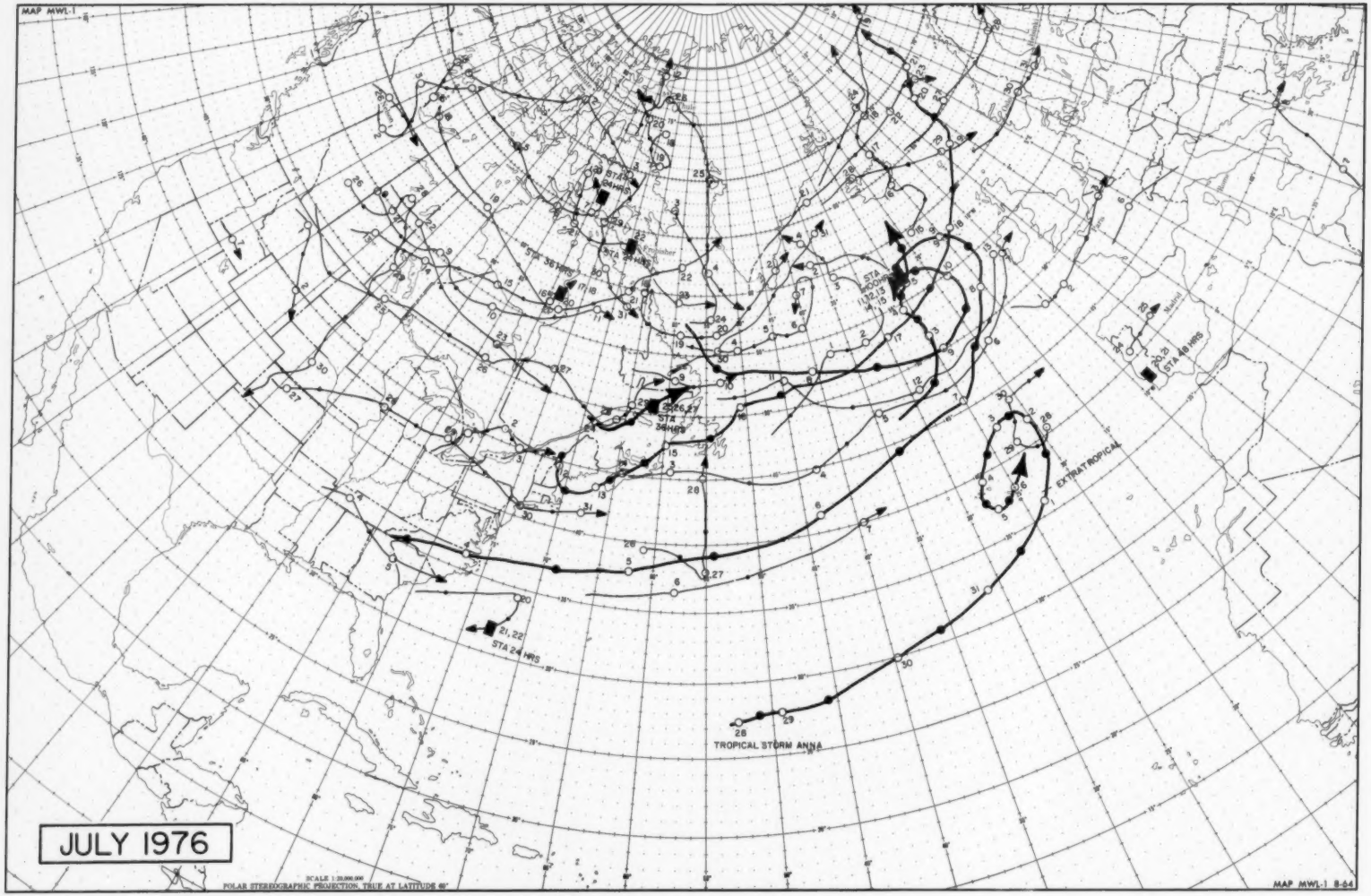

Figure 26. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

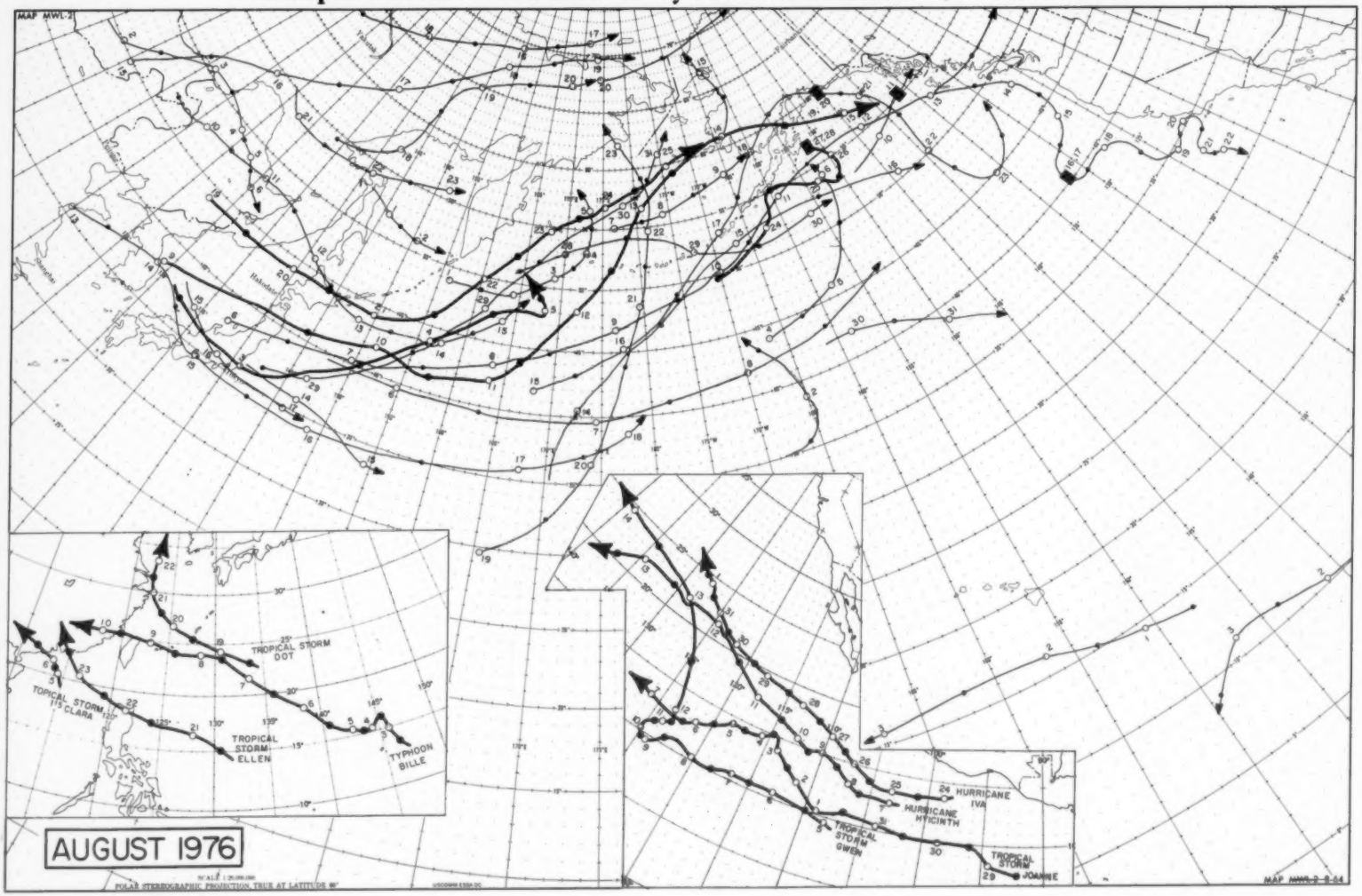

Figure 27. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Table 9
U. S. Ocean Weather Station Climatological Data, North Atlantic

Ocean Weather Station 'HOTEL' 38°00'N 71°00'W **July and August, 1976**

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
JULY	DATA NOT AVAILABLE																			
AUG	18.5	31 00	23.8	28.0	09 21	8.0	31 21	19.5	24.4	08 18	23.0	31 09	25.1	27.3	12 21	- 0.1	31 21	- 1.3	2.3	27 18

MONTH	MEANS AND EXTREMES PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS) TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER RAIN OR PCPN	DRZL	SNOW	TSTM	VISBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	SOBS WITH PCPN	NO OF OBS
JULY	DATA NOT AVAILABLE																							
AUG	1006.5	01 09	1019.0	1025.0	03 15	35.5	28.2	24.5	11.8	70.2	21.6	8.2	.0	7	7	8	8	8	3	1	0	31	6.1	245

** VV-90-93 AND/OR W-4 COMP OB DAYS-COMPLETE OB DAYS

Wind

JULY WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	DATA NOT AVAILABLE							
NE								
E								
SE								
S								
SW								
W								
NW								
CALM								
TOTAL								

NUMBER OF OBS | MAX WIND DIR | MAX WIND SPEED | MAX WIND DA HR | VECTOR SPEED | MEAN DIR (DIR IN DEGREES)

AUG WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	5.7	5.9	2.9	.0	.0	14.0	14.0
NE	.1	.9	6.8	1.9	.4	.0	9.6	17.6
E	.9	.4	.9	.0	.0	.0	1.9	10.3
SE	.4	1.1	.9	1.2	.8	.0	4.5	19.6
S	.8	7.8	7.2	.0	.7	.0	16.3	12.1
SW	1.3	8.9	12.4	.8	.1	.0	23.6	11.8
W	1.5	10.2	5.0	.0	.0	.0	16.7	8.7
NW	.8	4.0	4.7	.8	.0	.0	10.3	13.1
CALM	3.7	.0	.0	.0	.0	.0	3.7	.0
TOTAL	9.0	38.8	43.7	6.3	2.0	.0	100.0	12.2

NUMBER OF OBS 245 | MAX WIND DIR 170 | MAX WIND SPEED 55 | MAX WIND DA HR 09 2330 | VECTOR SPEED 2.5 | MEAN DIR 201 (DIR IN DEGREES)

Wave

JULY WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	DATA NOT AVAILABLE								
NE									
E									
SE									
S									
SW									
W									
NW									
IND									
CALM									
TOTAL									

NUMBER OF OBS IND-INDETERMINATE

AUG WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	1.3	4.8	1.3	.7	.0	.0	.0	.0	8.2
NE	.3	8.8	2.4	1.2	.1	.0	.0	.0	12.9
E	.0	2.6	.7	.9	.3	.0	.0	.0	4.5
SE	.8	11.2	1.6	.0	.4	.0	.0	.0	14.1
S	2.3	12.8	1.6	.0	.8	.7	.0	.0	18.3
SW	2.2	11.5	.0	.0	.0	.5	.0	.0	14.3
W	3.5	4.0	.0	.0	.0	.0	.0	.0	7.4
NW	.1	6.8	2.4	.0	.0	.0	.0	.0	9.4
IND	.8	6.9	.8	2.0	.4	.0	.0	.0	11.0
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	11.4	69.4	11.0	4.9	2.0	1.2	.0	.0	100.0

NUMBER OF OBS 245 IND-INDETERMINATE

JULY WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	DATA NOT AVAILABLE								
6-7									
8-9									
10-11									
12-13									
>13									
IND									
TOTAL									

NUMBER OF OBS | MAX WAVE HEIGHT HGT | PER | DIR | TYPE | DA HR | IND-INDETERMINATE (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

AUG WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	9.2	20.2	.8	.0	.0	.0	.0	.0	30.2
6-7	.4	20.8	8.9	1.6	.0	.0	.0	.0	31.4
8-9	1.8	10.6	.8	1.2	1.2	.0	.0	.0	15.5
10-11	.0	.8	.0	.0	.4	1.2	.0	.0	2.4
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	1.2	6.9	.8	2.0	.4	.0	.0	.0	11.4
TOTAL	11.4	69.4	11.0	4.9	2.0	1.2	.0	.0	100.0

NUMBER OF OBS 245 | MAX WAVE HEIGHT HGT 7.0 | PER 10 | DIR 180 | TYPE SEA | DA HR 10 00 | IND-INDETERMINATE (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 10
U. S. Ocean Buoy Climatological Data
July and August 1976

JULY — DATA SUMMARY — EB01

AVERAGE LATITUDE 35.0N — AVERAGE LONGITUDE 072.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	21.0	(05 03)	24.3	26.5	(06 15)	46	6
SEA TEMP (DEG C)	24.5	(01 12)	24.8	25.4	(03 21)	46	6
AIR-SEA TEMP (DEG C)	-03.0	(05 03)	-00.6	01.7	(06 15)	46	6
PRESSURE (MBAR)	1009.1	(05 09)	1016.7	1020.1	(03 15)	46	6

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		2.2					2.2	5.0
NE	4.4						4.4	1.0
E								
SE								
S	4.4	2.2	22.2	2.2			31.1	19.3
SW		4.4	17.8	6.7			28.9	18.1
W	2.2	6.7	6.7				15.6	9.3
NW	2.2	6.7	8.9				17.8	10.8
CALM								
TOTAL %	13.3	22.2	55.6	8.9			100.0	13.5

NO. OF OBS: 45

MAX WIND SPEED: 27 KNOTS DIRECTION: 230 DEG DAY: 06 HOUR: 09

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 44

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-8.9	>8.5	MEAN	MAX	(DA HR)
% FREQUENCY		43.2	56.8						1.0M	2.5M	(05 09)

AUGUST — DATA SUMMARY — EB01

AVERAGE LATITUDE 35.0N — AVERAGE LONGITUDE 072.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	22.0	(17 06)	25.3	26.8	(15 21)	68	10
SEA TEMP (DEG C)	26.2	(22 09)	26.6	27.4	(15 21)	68	10
AIR-SEA TEMP (DEG C)	-04.8	(17 06)	-01.3	00.2	(15 03)	68	10
PRESSURE (MBAR)	1011.7	(10 09)	1017.5	1023.1	(20 15)	68	10

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N			14.8	1.8			16.4	18.3
NE		1.5	10.4	3.0			14.8	17.1
E	1.5	1.5	17.9				20.8	12.1
SE	3.0	7.5					10.4	9.0
S		10.4	0.0				10.4	9.2
SW		6.0	10.4				16.4	10.1
W	1.5						1.5	2.0
NW								
CALM								
TOTAL %	6.0	26.9	82.7	4.5			100.0	12.1

NO. OF OBS: 67

MAX WIND SPEED: 23 KNOTS DIRECTION: 030 DEG DAY: 10 HOUR: 10

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 68

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-8.9	>8.5	MEAN	MAX	(DA HR)
% FREQUENCY		32.4	29.4	38.2					1.4M	2.6M	(22 00)

JULY — DATA SUMMARY — EB03

AVERAGE LATITUDE 56.0N — AVERAGE LONGITUDE 147.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	07.6	(11 12)	08.8	11.6	(31 03)	161	22
SEA TEMP (DEG C)	08.7	(08 12)	09.8	11.0	(31 03)	159	22
AIR-SEA TEMP (DEG C)	-01.7	(10 10)	-00.1	02.3	(09 18)	159	22
PRESSURE (MBAR)	0007.2	(21 10)	1013.5	1030.1	(30 21)	161	22

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		.6	1.8	3.1			5.6	11.8
NE		.6	2.5	1.2			4.3	9.6
E	1.2	5.6	11.8	.6			19.3	12.2
SE	1.2	6.8	6.2	3.7			17.8	13.6
S		11.2	2.5				13.7	8.9
SW	.6	8.7	8.2				15.5	8.7
W		10.6	8.1				18.8	10.0
NW	.6	2.5	.6				3.7	8.8
CALM	1.2						1.2	.0
TOTAL %	4.2	46.7	30.8	4.3			100.0	10.6

NO. OF OBS: 161

MAX WIND SPEED: 27 KNOTS DIRECTION: 120 DEG DAY: 23 HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 150

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-8.5	>8.5	MEAN	MAX	(DA HR)
% FREQUENCY	14.7	75.3	10.0						1.2M	2.5M	(21 09)

AUGUST — DATA SUMMARY — EB03

AVERAGE LATITUDE 56.0N — AVERAGE LONGITUDE 147.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.9	(26 15)	11.2	12.8	(22 00)	242	31
SEA TEMP (DEG C)	10.8	(28 12)	11.8	12.5	(24 03)	242	31
AIR-SEA TEMP (DEG C)	-02.2	(23 15)	-00.4	00.7	(11 08)	242	31
PRESSURE (MBAR)	0978.3	(26 12)	1010.7	1026.8	(01 00)	242	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	5.8	2.5				7.9	10.3
NE		2.9	.4				3.7	9.8
E	.4	9.8	5.7	.8	.4		18.4	12.2
SE	2.1	2.9	0.5	3.3	.4		10.3	15.1
S		5.3	14.9	2.5			20.7	15.8
SW		4.1	5.8	.4			10.4	11.5
W	.4	2.9	10.1	1.2			14.7	14.1
NW	.8	4.1	4.6				9.5	9.8
CALM	.4						.4	.0
TOTAL %	4.6	38.3	54.8	8.3	.8		100.0	13.3

NO. OF OBS: 241

MAX WIND SPEED: 36 KNOTS DIRECTION: 120 DEG DAY: 26 HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 238

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-8.5	>8.5	MEAN	MAX	(DA HR)
% FREQUENCY	7.1	90.8	24.7	7.9	1.7				1.6M	4.5M	(27 03)

JULY — DATA SUMMARY — EB04

AVERAGE LATITUDE 26.0N — AVERAGE LONGITUDE 090.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	26.4	(25 09)	28.0	31.0	(30 21)	87	11
DEWPOINT TEMP (DEG C)	21.5	(24 06)	23.2	24.8	(21 03)	87	11
SEA TEMP (DEG C)	28.2	(28 12)	29.2	30.1	(25 00)	87	11
AIR-SEA TEMP (DEG C)	-02.8	(25 03)	-01.2	02.2	(30 21)	87	11
PRESSURE (MBAR)	1015.8	(28 00)	1018.2	1021.6	(25 18)	87	11

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	2.3	2.3	2.3				6.9	8.0
NE	6.7	5.4	1.1				13.3	4.7
E	8.9	26.4	6.9				40.2	7.3
SE	6.9	10.1	1.1				18.4	6.3
S	4.6	3.4	1.1				9.2	5.4
SW	2.3	1.1					3.4	2.7
W	2.3						2.3	1.5
NW	1.1	1.1					2.3	3.0
CALM								
TOTAL %	32.2	54.0	13.8				100.0	6.3

NO. OF OBS: 87

MAX WIND SPEED: 18 KNOTS DIRECTION: 350 DEG DAY: 31 HOUR: 21

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 79

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-8.5	>8.5	MEAN	MAX	(DA HR)
% FREQUENCY	100.0								.3M	.5M	(31 03)

PRECIPITATION

NO. OF DAYS WITH PRECIP: 3 NO. OF DAYS WITH REPORTS/ COMPLETE: 10 PARTIAL: 1

NO. OF OBS WITH PAST OR PRESENT PRECIP: 3 NO. OF WEATHER OBS: 3

AUGUST — DATA SUMMARY — EB04

AVERAGE LATITUDE 26.0N — AVERAGE LONGITUDE 090.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	22.8	(21 15)	27.0	32.2	(05 21)	220	29
DEWPOINT TEMP (DEG C)	18.3	(09 09)	23.8	26.0	(26 09)	226	29
SEA TEMP (DEG C)	28.2	(01 18)	29.1	29.8	(08 21)	25	4
AIR-SEA TEMP (DEG C)	-04.2	(01 18)	-01.5	00.1	(09 21)	25	4
PRESSURE (MBAR)	1011.2	(10 21)	1016.2	1021.0	(12 15)	220	29

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.4	6.3	3.5				11.1	7.6
NE	1.4	6.9	3.5				11.8	8.1
E	2.8	13.9	4.9				21.5	7.1
SE	2.8	9.0	1.4				13.2	6.2
S	2.1	7.6	1.4				11.1	6.8
SW	1.4	3.5	.7				5.6	5.1
W	4.2	7.6	2.1				13.9	5.1
NW	3.5	5.6	2.1				11.1	6.1
CALM								
TOTAL %	19.8	57.6	23.6				100.0	7.0

NO. OF OBS: 144

MAX WIND SPEED: 15 KNOTS DIRECTION: 190 DEG DAY: 14 HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 127

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-8.5	>8.5	MEAN	MAX	(DA HR)
% FREQUENCY	99.2	.8							.4M	1.0M	(10 09)

PRECIPITATION

NO. OF DAYS WITH PRECIP: 8 NO. OF DAYS WITH REPORTS/ COMPLETE: 26 PARTIAL: 3

NO. OF OBS WITH PAST OR PRESENT PRECIP: 10 NO. OF WEATHER OBS: 10

JULY — DATA SUMMARY — EB19

AVERAGE LATITUDE 32.3N — AVERAGE LONGITUDE 079.3W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	21.2	(19 15)	25.8	27.6	(31 18)	237	31
SEA TEMP (DEG C)	25.8	(02 18)	27.0	28.6	(28 00)	237	31
AIR-SEA TEMP (DEG C)	-05.7	(19 12)	-01.2	00.5	(12 21)	237	31
PRESSURE (MBAR)	1007.9	(13 09)	1017.6	1023.9	(19 15)	237	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.3	1.3	.4				3.0	9.2
NE	1.7	2.5	1.3				5.5	8.5
E	.4	1.7	.4				2.5	7.7
SE			.4				.4	17.0
S	.8	4.2	10.1	.4			15.6	13.0
SW	1.3	5.5	34.8	2.1			43.6	14.1
W	.4	3.4	10.5	.8			23.2	14.8
NW	1.7	4.2	.4				6.3	6.2
CALM								
TOTAL %	7.8	22.8	68.2	3.4			100.0	12.8

NO. OF OBS: 237

MAX WIND SPEED: 29 KNOTS DIRECTION: 250 DEG DAY: 05 HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 236

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-8.5	>8.5	MEAN	MAX	(DA HR)
% FREQUENCY	28.1	69.1	2.4	.4					1.0M	3.0M	(13 09)

AUGUST — DATA SUMMARY — EB19

AVERAGE LATITUDE 32.3N — AVERAGE LONGITUDE 079.3W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	21.4	(04 12)	25.7	28.4	(22 15)	243	31
SEA TEMP (DEG C)	26.3	(18 00)	26.8	28.4	(29 21)	243	31
AIR-SEA TEMP (DEG C)	-06.3	(04 12)	-01.2	02.8	(22 15)	243	31
PRESSURE (MBAR)	0985.2	(08 06)	1017.3	1024.3	(11 15)	240	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.8	2.5	2.1				5.3	8.4
NE		3.7	5.0	2.5	.4		12.5	10.2
E	.4	9.5	12.3	.8			23.0	11.8
SE	.4	8.0	7.0				17.3	10.4
S	.8	7.0	8.8	1.5			18.1	12.0
SW	2.1	3.3	7.0	2.9	.4	.8	15.6	15.3
W	1.0	2.1	.8	.4			5.3	11.1
NW		2.1					2.1	7.4
CALM	.8						.8	.0
TOTAL %	7.0	38.9	43.6	8.2	.4	.8	100.0	12.3

NO. OF OBS: 243

MAX WIND SPEED: 30 KNOTS DIRECTION: 230 DEG DAY: 08 HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 184

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-8.5	>8.5	MEAN	MAX	(DA HR)
% FREQUENCY	4.9	58.9	33.3	3.8	.5	1.1			1.7M	7.0M	(08 06)

JULY — DATA SUMMARY — EB16

AVERAGE LATITUDE 42.5N — AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	12.7	(31 12)	14.0	15.3	(31 21)	29	4
SEA TEMP (DEG C)	13.8	(01 18)	15.2	16.3	(26 00)	244	31
AIR-SEA TEMP (DEG C)	-02.8	(31 12)	-01.3	-00.4	(31 21)	28	4
PRESSURE (MBAR)	1008.5	(07 15)	1019.0	1027.3	(24 21)	244	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	6.6	20.9	6.1			34.0	14.8
NE	.4						.4	1.0
E	.4						.4	3.0
SE	.8		2.0				2.9	11.1
S		3.7	9.2	1.2			13.1	14.1
SW		9.7	13.5	.4			23.7	12.9
W		6.1	13.1				19.3	13.9
NW	.8	2.9	8.1				9.8	11.2
CALM	.4						.4	.0
TOTAL	3.3	25.0	63.8	7.8			100.0	13.2

MEAN WIND — NO. OF OBS: 244
SPEED: 25 KNOTS
DIRECTION: 010 DEG
DAY: 28
HOUR: 12

JULY — DATA SUMMARY — EB17

AVERAGE LATITUDE 52.0N — AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.5	(13 18)	09.0	10.9	(20 12)	213	27
SEA TEMP (DEG C)	08.8	(06 21)	09.6	11.1	(31 03)	212	27
AIR-SEA TEMP (DEG C)	-02.8	(13 18)	-00.6	01.2	(20 12)	212	27
PRESSURE (MBAR)	0998.1	(06 21)	1012.6	1030.5	(31 21)	213	27

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		3.3	8.9	.9			13.7	12.8
NE		.9	3.8				4.7	12.4
E		1.4	4.7				6.1	13.2
SE		1.4	.9	2.3			4.7	17.9
S		6.6	15.0	.9			22.5	13.8
SW		4.7	8.5				13.1	12.3
W		8.0	14.1	.9			23.0	13.5
NW		8.0	4.7				12.7	10.1
CALM	.5						.5	.0
TOTAL	.5	34.3	60.6	4.7			100.0	13.0

MEAN WIND — NO. OF OBS: 213
SPEED: 26 KNOTS
DIRECTION: 140 DEG
DAY: 28
HOUR: 00

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 200

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	11.5	53.0	33.5	2.0					1.5M	3.5M (20 09)

JULY — DATA SUMMARY — EB41

AVERAGE LATITUDE 38.7N — AVERAGE LONGITUDE 073.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	19.8	(13 15)	22.6	25.4	(31 21)	246	31
SEA TEMP (DEG C)	21.0	(14 15)	22.7	25.3	(31 21)	246	31
AIR-SEA TEMP (DEG C)	-02.3	(13 06)	-00.1	01.6	(10 00)	245	31
PRESSURE (MBAR)	0988.5	(12 18)	1014.1	1025.5	(19 15)	246	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.8	5.0	2.1				7.9	8.8
NE	.8	1.7					2.5	5.3
E	.4	4.7	.4				5.5	9.9
SE	1.2	2.9	2.1				6.2	7.5
S	1.2	6.5	15.6	.4			24.0	12.0
SW	1.2	13.7	12.4	.8			28.2	10.5
W	.4	8.5	9.1	1.2			20.3	11.5
NW	.4	2.9	2.5	1.2			7.1	11.9
CALM	.4						.4	.0
TOTAL	7.1	44.0	45.2	3.7			100.0	10.6

MEAN WIND — NO. OF OBS: 241
SPEED: 27 KNOTS
DIRECTION: 230 DEG
DAY: 04
HOUR: 00

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	48.4	46.6	4.0						.8M	2.0M (27 18)

JULY — DATA SUMMARY — EB34

AVERAGE LATITUDE 48.1N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	10.4	(13 08)	22.3	24.8	(30 21)	244	31
SEA TEMP (DEG C)	20.8	(14 08)	22.8	24.7	(23 21)	244	31
AIR-SEA TEMP (DEG C)	-04.7	(26 18)	-00.6	01.7	(12 08)	243	31
PRESSURE (MBAR)	0992.8	(12 08)	1012.2	1023.4	(20 03)	244	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	2.0	4.9	2.0				8.9	8.8
NE	.4	2.5	.4				3.3	8.3
E	.4	1.2	.8				2.9	7.0
SE	.4	3.3	1.6				5.3	7.8
S		2.5	6.6				9.0	12.4
SW	.8	8.2	22.1				31.1	12.2
W	1.6	10.7	20.5				32.8	11.3
NW	.4	3.3	2.9				6.6	10.3
CALM	.4						.4	.0
TOTAL	8.0	36.5	57.0				100.0	10.7

MEAN WIND — NO. OF OBS: 244
SPEED: 21 KNOTS
DIRECTION: 200 DEG
DAY: 13
HOUR: 06

AUGUST — DATA SUMMARY — EB36

AVERAGE LATITUDE 55.3N — AVERAGE LONGITUDE 157.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	09.6	(31 21)	10.4	11.6	(23 00)	64	10
SEA TEMP (DEG C)	09.2	(30 15)	10.2	10.9	(24 12)	63	10
AIR-SEA TEMP (DEG C)	-00.7	(23 12)	00.2	01.1	(29 03)	63	10
PRESSURE (MBAR)	0988.3	(26 06)	1008.7	1024.6	(22 12)	62	10

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		3.2	9.7				12.9	12.0
NE		1.6	3.2				4.8	9.7
E	1.6	4.8					6.5	6.0
SE	1.6	1.6	12.9	1.6			17.7	13.5
S		3.2	1.6				4.8	8.7
SW		3.2	4.8				8.1	11.8
W		6.5	12.9				19.4	10.6
NW		4.8	21.0				25.8	12.9
CALM								
TOTAL	3.2	29.0	66.1	1.6			100.0	11.5

AUGUST — DATA SUMMARY — EB16

AVERAGE LATITUDE 42.5N — AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	12.7	(06 15)	15.3	17.7	(30 21)	247	31
SEA TEMP (DEG C)	15.7	(08 15)	16.5	18.4	(31 00)	248	31
AIR-SEA TEMP (DEG C)	-03.1	(06 15)	-01.2	00.4	(01 00)	247	31
PRESSURE (MBAR)	1008.2	(16 00)	1018.9	1025.4	(12 18)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	9.3	17.7	.4			27.8	12.8
NE	.4	.8	3.2				4.4	12.8
E	1.2	4.0	2.4				7.7	7.6
SE	.4	5.2					5.6	5.8
S	.8	2.8	.8	.4			4.8	9.5
SW	.8	2.0	4.8				7.7	11.3
W	1.2	8.5	8.1	.4			18.1	10.8
NW	.4	8.9	15.7				25.0	12.4
CALM	.8						.8	.0
TOTAL	6.5	41.5	50.8	1.2			100.0	11.1

MEAN WIND — NO. OF OBS: 248
SPEED: 24 KNOTS
DIRECTION: 170 DEG
DAY: 29
HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 195

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		75.4	24.6						1.5M	2.5M (18 00)

AUGUST — DATA SUMMARY — EB17

AVERAGE LATITUDE 52.0N — AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.8	(23 09)	10.3	12.1	(01 21)	242	31
SEA TEMP (DEG C)	10.2	(28 15)	10.7	12.3	(01 09)	242	31
AIR-SEA TEMP (DEG C)	-01.6	(23 09)	-00.4	00.8	(17 18)	240	31
PRESSURE (MBAR)	0985.8	(25 21)	1013.0	1030.9	(01 06)	244	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		.8	1.2				2.0	13.8
NE		1.2		1.6			2.8	17.0
E		.8	2.8	.4			4.1	14.0
SE	.4	.4	1.6	1.2			3.7	17.3
S		2.0	5.3	2.0			9.4	15.2
SW		2.0	11.8	1.2			15.2	15.2
W	.4	7.1	6.5	10.4			50.4	17.8
NW	.8	1.2	8.6	1.6			12.3	14.8
CALM								
TOTAL	1.6	16.0	57.8	24.6			100.0	16.4

MEAN WIND — NO. OF OBS: 244
SPEED: 32 KNOTS
DIRECTION: 150 DEG
DAY: 31
HOUR: 21

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 231

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	5.2	46.3	34.2	13.0	1.3				1.8M	4.0M (19 09)

AUGUST — DATA SUMMARY — EB41

AVERAGE LATITUDE 38.7N — AVERAGE LONGITUDE 073.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	18.8	(30 15)	22.0	24.7	(01 00)	237	31
SEA TEMP (DEG C)	18.7	(10 03)	22.5	25.1	(01 00)	237	31
AIR-SEA TEMP (DEG C)	-04.4	(30 15)	-00.5	02.5	(10 03)	237	31
PRESSURE (MBAR)	0978.0	(10 00)	1018.7	1027.7	(20 19)	236	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.5	3.8	7.1	1.4			12.8	13.5
NE	1.8	4.3	6.2	1.8			12.4	11.3
E	1.0	1.4	1.0	.5			3.8	12.1
SE	.5	1.4	2.4	.5			4.8	12.5
S		8.2	20.6				34.8	12.8
SW		7.1	7.1	.8	.8		15.2	11.6
W		4.3	3.8	.5			8.6	10.5
NW	.5	2.8	4.3				7.6	10.4
CALM								
TOTAL	3.3	31.4	60.5	3.3	1.4		100.0	12.1

MEAN WIND — NO. OF OBS: 210
SPEED: 36 KNOTS
DIRECTION: 240 DEG
DAY: 10
HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 240

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	28.8	56.7	11.3	2.5	.4	.4			1.1M	6.0M (10 00)

AUGUST — DATA SUMMARY — EB18

AVERAGE LATITUDE 51.0N — AVERAGE LONGITUDE 136.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	11.0	(21 21)	12.2	13.7	(17 21)	127	17
SEA TEMP (DEG C)	12.2	(21 15)	12.9	13.6	(30 21)	127	17
AIR-SEA TEMP (DEG C)	-02.1	(25 12)	-00.7	00.5	(17 21)	126	17
PRESSURE (MBAR)	1005.8	(26 15)	1015.8	1026.5	(31 06)	128	17

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		1.6	3.1				4.7	13.7
NE	1.6	2.3	2.3				6.3	8.4
E		5.5					5.5	7.2
SE	1.6	6.3		1.6			9.4	9.0
S	1.6	8.6	10.9	1.6			22.7	11.5
SW		7.0	14.1				21.1	12.2
W	3.1	1.6	14.8	1.6			21.1	13.1
NW		1.6	6.3				7.8	12.9
CALM	1.6						1.6	.0
TOTAL	9.4	34.4	51.6	4.7			100.0	11.9

MEAN WIND — NO. OF OBS: 128
SPEED: 28 KNOTS
DIRECTION: 160 DEG
DAY: 26
HOUR: 12

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 121

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	.8	56.7	40.5						1.8M	2.5M (27 21)

Table 11
Selected Gale and Wave Observations, North Atlantic
July and August 1976

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C Air	Temperature °C Sea	Sea Waves* Period sec.	Sea Waves* Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.*	Swell Waves Height ft.
NORTH ATLANTIC OCEAN		JULY																
MEADOWBROOK	AMERICAN	1	34.6 N	75.2 W	00	20	N	40	5 NM	03	1012.5	27.2	27.8	2	10			
FALSTRIA	DANISH	2	14.0 N	74.0 W	12	08	N	35	10 NM	02	1014.1	27.9		8	11.5			
SEALAND MARKET	AMERICAN	5	39.4 N	50.7 W	06	04		35	5 NM	15	1014.8	20.0	20.6					
YUKON	AMERICAN	8	13.3 N	71.8 W	06	07		35	5 NM	02	1011.2	26.4	28.2	4	10	08	7	13
FARSTFJORD	NORWEGIAN	9	18.3 N	58.2 W	18	09		36	> 25 NM	02	1019.5	27.6						
AMER LIBERTY	AMERICAN	9	13.3 N	77.9 W	18	07		35	5 NM	01	1010.8	27.8	28.1	6	10	07	13	18
MOBIL LUBE	AMERICAN	12	34.0 N	75.3 W	00	23		35	10 NM	01	1012.5	27.5	27.7	10	10	21	9	14.5
CARBIDE SEADRIFT	AMERICAN	13	38.5 N	73.1 W	06	32		35	5 NM	02	1002.0	20.6	23.3	5	10			
LONG BEACH	AMERICAN	14	12.7 N	75.7 W	18	07		35	5 NM	01	1012.6	26.7	26.7	3	5	08	6	8
SEALAND MARKET	AMERICAN	14	48.1 N	13.6 W	18	20		40	5 NM	80	1005.8	18.3	14.0	12	19.5			
AMER LEADER	AMERICAN	14	40.4 N	58.4 W	12	20		36	5 NM	25	1008.2	24.4	25.0			20	8	14.5
MEADOWBROOK	AMERICAN	15	12.5 N	81.2 W	12	07		35	10 NM	02	1011.5	27.8	27.8	8	13			
LONG BEACH	AMERICAN	15	14.2 N	73.9 W	06	07		35	5 NM	02	1013.8	26.7	27.2	6	10	07	8	11.5
VELMA LYKES	AMERICAN	15	13.7 N	78.2 W	12	09		44	10 NM	01	1014.0	28.3	28.7	7	8.5	09	8	11.5
VELMA LYKES	AMERICAN	16	12.9 N	75.3 W	00	09		44	10 NM	02	1013.0	27.2	28.7	7	8	09	10	18
AUSTRAL ENTENTE	AMERICAN	16	10.9 N	80.6 W	00	05		35	5 NM	03	1009.1	27.7	27.7	3	6.5			
SANTA BARBARA	AMERICAN	17	11.2 N	78.8 W	00	06		35	5 NM	03	1008.5	26.8	28.3	5	8	06	7	14.5
OTTO N MILLER	LIBERIAN	22	42.2 N	10.0 W	00	03	N	36	10 NM	02	1017.0	19.0	16.1					
GULFSHIPPER	AMERICAN	28	13.2 N	77.7 W	12	06		40	10 NM	02	1010.0	27.4	25.5	6	13			
GULFSHIPPER	AMERICAN	29	12.1 N	75.7 W	00	06		35	10 NM	02	1008.5	26.9	25.0	6	13			
FALSTRIA	DANISH	31	12.9 N	75.2 W	12	09	N	35	10 NM	03	1007.4	27.7		8	19.5			
GREAT LAKES VESSELS																		
ARMCO	AMERICAN	1	44.8 N	82.7 W	00	04	N	45	2 NM	18		12.0	13.0	4	16.5			
WILLIS B BOYER	AMERICAN	7	47.5 N	89.5 W	00	31	N	36	< 50 YD			10.0	7.0	3	3			
CHAMPLAIN	AMERICAN	10	45.5 N	83.4 W	06	16	N	38	8 NM	18		18.0	10.0	2	3			
MIDDLETOWN	AMERICAN	12	45.1 N	83.1 W	06	01	N	35	10 NM	03		18.0	14.0	2	5			
WILLIS B BOYER	AMERICAN	12	44.2 N	82.7 W	18	30	N	46	> 25 NM	01		17.0	17.0	4	6.5			
NORTH ATLANTIC OCEAN		AUG.																
HOEY QUEEN	SINGAPORE	1	21.4 N	18.0 W	00	36		37	5 NM	01	1012.5	22.0	23.0	7	11.5			
ITALICA	ITALIAN	2	40.2 N	19.9 W	00	10		50	2 NM	60	1016.0	22.0	22.0	8	16.5			
OAKLAND	AMERICAN	3	20.2 N	74.0 W	12	09		38	5 NM	02	1018.3	26.7	27.7	4	6.5	09	8	13
EXXON BALTIMORE	AMERICAN	3	18.1 N	78.5 W	00	09		38	10 NM	02	1013.5	26.0	31.1	19	10			
TRINITY	AMERICAN	3	17.9 N	67.2 W	00	09		50	1 NM	62	1017.7	25.0	29.0	3	10			
MAYAGUEZ	AMERICAN	9	30.8 N	70.8 W	06	16		35(B)	5 NM	02	1012.9	26.7	26.7	3	6	17	6	14.5
NEW JERSEY SUN	AMERICAN	9	30.5 N	71.8 W	18	17		45(B)	5 NM	18	1011.2	25.0	25.7	2	5	23	>13	11.5
EXXON SAN FRANCISCO	AMERICAN	9	37.6 N	74.8 W	18	01		45(B)	1 NM	64	999.8	24.2	27.8	2	8	01	6	10
EXXON BALTIMORE	AMERICAN	9	36.3 N	73.0 W	18	18		60(B)	.5 NM	21	1000.7	24.0	30.0			18	>13	59.5
EXXON BOSTON	AMERICAN	9	37.3 N	71.9 W	21	14		50(B)	5 NM	02	1010.7	26.5	25.6	3	16.5			
GLOMAR CHALLENGER	AMERICAN	9	38.7 N	25.9 W	12	22	N	41	10 NM	02	1009.3	11.0	11.2	5	5	22	10	18
CHEROKEE	AMERICAN	9	37.1 N	73.8 W	19	31	N	37(B)	.5 NM	81	1001.0	21.1	27.8	8	13			
NEW JERSEY SUN	AMERICAN	10	36.5 N	70.7 W	00	18		35(B)	5 NM	18	1014.2	22.0	28.8	4	6.5	23	>13	11.5
ITALICA	ITALIAN	10	37.9 N	71.7 W	00	18		50(B)	5 NM	02	1015.0	25.0	26.0	XX	32.5			
EXXON BALTIMORE	AMERICAN	10	35.7 N	72.6 W	00	24		35(B)	5 NM	02	1019.2	23.8	30.0	13	19.5			
EXPORT PATRIOT	AMERICAN	10	38.4 N	68.6 W	00	18		40(B)	5 NM	02	1017.3	27.0	26.2	4	10	18	7	14.5
SHERMAN	AMERICAN	10	41.8 N	70.2 W	12	20	N	40(B)	5 NM	02	1007.5	20.0	19.8	4	8			
AMER CHAMPION	AMERICAN	10	38.9 N	70.3 W	06	20		35(B)	10 NM	02	1016.5	23.9	24.2	4	6.5	20	8	14.5
LIGHTNING	AMERICAN	19	40.7 N	65.8 W	18	05		38(C)	5 NM	02	1018.0	20.3	26.2	7	8			
TEXAS TRADER	AMERICAN	19	25.7 N	79.9 W	18	20		40(D)	5 NM	97	1005.8	28.5	30.0	5	11.5	20	< 6	14.5
CHEVRON LONDON	LIBERIAN	19	40.6 N	61.0 W	18	08	N	36(C)	2 NM	21	1023.0	21.7	26.7	9	13			
MOBIL FUEL	AMERICAN	20	34.2 N	76.1 W	00	03		40(D)	5 NM	25	1020.7	23.3	27.8	7	10			
SAN RATULANGIE	INDONESIAN	20	30.5 N	76.5 W	12	17	N	40(D)	2 NM	50	1016.0	27.2	28.0	5	6.5			
CHASTINE MAERSK	DANISH	20	38.8 N	60.5 W	18	24		35(C)	5 NM	81	1013.2	23.4	28.0	7	10			
EXXON WASHINGTON	AMERICAN	20	32.7 N	77.0 W	18	11		40(D)	9 NM	25	1016.6	26.2	28.9	XX	8			
EXXON CHESTER	AMERICAN	20	33.3 N	77.7 W	23	14		35(D)	5 NM	25	1014.6	25.0	28.7	5	8	14	12	19.5
CHEVRON LONDON	LIBERIAN	20	39.3 N	58.3 W	06	17	N	36(C)	10 NM	21	1023.0	26.7	26.1	9	13			
AMER LEGACY	AMERICAN	21	41.7 N	63.3 W	00	19		45(C)	10 NM	01	1018.3	19.4	24.3	5	11.5	08	7	10
DALLAS	AMERICAN	21	39.2 N	62.6 W	00	20	N	37(C)	10 NM	01	1018.0	22.7	24.4	4	8			
BAMAR	NORWEGIAN	21	40.3 N	39.0 W	18	32		45(C)	2 NM	25	993.0	24.0	27.0	12	32.5			
EXPORT DEFENDER	AMERICAN	22	37.6 N	56.1 W	18	22		35(C)	5 NM	02	1013.5	26.2	27.8	5	10			
BAMAR	NORWEGIAN	22	40.3 N	40.2 W	00	33		41(C)	2 NM	81	1008.0	23.1	27.0					
SEALAND RESOURCE	AMERICAN	22	38.2 N	14.2 W	00	27		35	5 NM	02	1010.0	21.1	21.1	5	10			
MAUREE	AMERICAN	26	52.4 N	55.0 W	00	35		35	10 NM	03	1012.5	6.2	8.4	6	8	36	7	14.5
DALLAS	AMERICAN	26	44.2 N	47.6 W	18	36	N	38	10 NM	05	1019.2	13.5		2	3			
LIGHTNING	AMERICAN	27	46.8 N	34.2 W	06	14		33	2 NM	51	1007.8	18.9	17.2	5	6.5			
JEAN LYKES	AMERICAN	27	44.5 N	40.9 W	18	34		38	10 NM	15	1022.0	19.7	19.4	8	16.5			
GREAT REPUBLIC	AMERICAN	27	44.1 N	36.0 W	18	33		35	5 NM	21	1019.6	18.6	17.7	6	14.5	30	12	18
AMER LEGEND	AMERICAN	27	49.4 N	24.2 W	12	19	N	37	1 NM	80	1008.0	17.2	13.4	5	10	19	9	14.5
ZIM TOKYO	GERMAN	28	41.3 N	37.6 W	00	33		44	5 NM	02	1020.0	18.0	22.0					
PIONEER CRUSADER	AMERICAN	29	46.5 N	37.7 W	00	02		38	5 NM	02	1020.7	13.2	17.8	7	11.5	02	12	32.5
PATRLOAD	NETHERLANDS	29	40.3 N	38.1 W	06	03		40	10 NM	28	1008.0		24.0	6	8	29	>13	13
ECUADORIAN REEFER	DANISH	29	37.6 N	39.0 W	12	36		36	> 25 NM	01	1005.5	21.0	21.5	4	13	36	8	19.5
GLOMAR CHALLENGER	AMERICAN	29	36.5 N	33.1 W	03	27	N	40	5 NM	25	1007.3	20.6	22.7	6	8	30	10	14.5
SEALAND MARKET	AMERICAN	29	33.5 N	37.1 W	17	31		38	10 NM	02	1014.0	23.2	20.6	8	13	34	11	18
PATRLOAD	NETHERLANDS	30	40.5 N	33.3 W	06	03		40	10 NM	82	1003.8	19.0	22.5	7	8	03	>13	13
SEALAND MARKET	AMERICAN	30	30.9 N	50.2 W	18	28		38(E)	10 NM	07	1009.5	27.0	22.7	12	16.5			
EXPORT DEMOCRACY	AMERICAN	30	40.3 N	35.8 W	18	05		35	5 NM	02	1011.2	21.1	20.6	2	5	05	6	13
TRIANFE	AMERICAN	31	41.9 N	32.8 W	18	07		35	2 NM	10	1013.9	18.8	18.3	4	10	07	7	16.5
SEALAND RESOURCE	AMERICAN	31	32.8 N	42.0 W	12	21		40(E)	2 NM	02	1008.3	28.1	23.6	9	8	21	8	18
OCEAN STATION VESSELS																		
ATLANTIC M																		
MORGENTHAU	AMERICAN	9	38.0 N	71.0 W	18	15	N	37	10 NM	03	1013.5	26.9	25.6	7	10	17	8	13
MORGENTHAU	AMERICAN	10	38.0 N	71.0 W	00	18	N	45	5 NM	16	1011.3	26.0	25.8	10	23			
GALLATIN	AMERICAN	19	38.0 N	71.0 W	03	03	N	35	10 NM	02	1017.8	22.2	23.2	8	11.5			
GREAT LAKES VESSELS																		
WILLIS B BOYER	AMERICAN	27	47.5 N	89.2 W	18	19	N	46	5 NM	03		18.0	19.0	3	5			
G W HUMPHREY	AMERICAN	28	47.3 N	89.3 W	06	21	N	39	10 NM	02		18.0	18.0	7	6.5			
ARMCO	AMERICAN	28	47.5 N	87.6 W	18	27	N	39	10 NM	02		14.0	14.0	3	6.5			
WILLIS B BOYER	AMERICAN	28	47.6 N	87.9 W	18	25	N	42	> 25 NM	02		15.0	17.0	7	10			
SAMUEL MATHER	AMERICAN	28	47.1 N	87.0 W	18	25	N	40	10 NM	03		21.0	19.0	8	10			

\+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind
(B) Hurricane Belle
(C) Hurricane Candice
(D) Tropical storm Dottie
(E) Hurricane Emmy

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

Table 12

Selected Gale and Wave Observations, North Pacific

July and August 1976

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.		Visibility n. mi.	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves* Period sec.	Sea Waves* Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.*	Swell Waves Height ft.
NORTH PACIFIC OCEAN		JULY																
PRESIDENT MADISON	AMERICAN	1	34.9 N	140.1 E	00	04	35		5 NM	02	1013.0	17.8	18.3	5	8			
LAUREL	LIBERIAN	1	34.9 N	123.0 W	18	32	M 38		10 NM	02	1016.0	14.5	15.0	3	5	30	7	8
CHALMETTE	LIBERIAN	2	24.1 N	135.1 E	18	27	28	(R)	1 NM	82	999.2	27.0	27.0	XX	10	25	>13	26
CORAL ARCADIA	LIBERIAN	3	24.4 N	138.6 E	00	05	M 42	(R)	5 NM	50	1008.0	17.5	24.0	4	6.5			
CHALMETTE	LIBERIAN	3	24.8 N	134.4 E	00	27	28	(R)	.5 NM	80	1003.7	30.5	27.0	XX	10	25	>13	26
BREWSTER	PANAMANIAN	3	43.5 N	169.6 E	12	11	M 50	(S)	.5 NM	05	973.5	10.0	9.5	6	16.5			
STAR DAVANGER	NORWEGIAN	3	37.5 N	162.0 E	03	32	60	(S)	2 NM	07	984.6	17.8	17.5					
COSMOS GIENAH	LIBERIAN	3	32.1 N	164.9 E	06	25	35		5 NM	03	1007.5	24.5	23.0	7	19.5			
PRESIDENT MADISON	AMERICAN	3	42.2 N	167.2 E	18	27	43	(S)	5 NM	02	999.0	8.9	6.7	5	8	32	11	19.5
PLUTOS	GERMAN	3	38.8 N	172.0 E	12	24	35	(S)	5 NM	25	1004.2	19.0	17.0	8	11.5	27	9	13
PAN ASIA	PANAMANIAN	3	45.4 N	166.7 E	18	34	M 38	(S)	.5 NM	53	982.0	6.5	11.0	4	6.5	07	7	16.5
ROBERTS BANK	LIBERIAN	3	36.2 N	146.9 W	00	31	M 35	(R)	10 NM	01	1019.0	21.0	21.1	4	5			
METEOR(T-AKR9)	AMERICAN	3	34.8 N	140.5 E	21	01	35	(R)	2 NM	02	1003.5	19.4	24.4	6	8	02	8	18
PRES GRANT	AMERICAN	3	41.7 N	166.4 E	07	05	55	(S)	200 YD	65	973.2	10.0	9.4	5	11.5			
MARY S	LIBERIAN	3	39.0 N	163.1 E	06	32	37	(S)	1 NM	63	997.8	15.0	21.0	6	8			
BREWSTER	PANAMANIAN	4	43.6 N	171.8 E	00	23	M 50	(S)	.25 NM	05	988.0	12.0	6.0	7	19.5	20	7	18
GOLDEN GATE	AMERICAN	4	46.7 N	162.1 W	06	33	35		10 NM	01	1010.1	8.3	6.1	3	6.5	34	7	16.5
SEALAND EXCHANGE	AMERICAN	4	41.7 N	169.0 E	18	28	35	(S)	5 NM	02	1007.1	8.7	7.7	5	8	31	8	16.5
ROBERTS BANK	LIBERIAN	4	37.0 N	154.5 W	00	25	M 38	(S)	10 NM	02	1015.5	22.5	21.7	4	6.5	28	6	10
PRESIDENT MADISON	AMERICAN	4	42.6 N	170.0 E	06	25	41	(S)	10 NM	03	1001.5	12.2	6.1	5	8	24	>13	26
PRES GRANT	AMERICAN	4	43.5 N	169.5 E	06	25	45	(S)	2 NM	02	999.0	8.3	6.1	7	19.5	27	10	29.5
METEOR(T-AKR9)	AMERICAN	4	35.0 N	141.1 E	00	02	35	(R)	10 NM	02	1005.5	17.8	23.9	6	11.5	02	8	18
PAN ASIA	PANAMANIAN	4	45.7 N	170.7 E	06	24	M 40	(S)	.5 NM	51	988.5	6.5	9.0	7	19.5	24	11	26
GOLDEN GATE	AMERICAN	5	43.6 N	173.5 W	18	27	45		5 NM	81	989.7	11.1	7.2	4	10	28	8	23
ROBERTS BANK	LIBERIAN	5	37.9 N	167.8 W	18	20	M 44		5 NM	50	1013.5	20.5	18.9	3	6.5	26	10	8
SEALAND COMMERCE	AMERICAN	5	37.7 N	152.7 W	18	27	35		5 NM	15	1015.8	20.6	16.7	6	10			
PLUVTUS	GERMAN	5	45.6 N	175.0 E	06	29	37		2 NM	01	992.5	7.8	6.9	8	11.5	23	7	8
SEALAND EXCHANGE	AMERICAN	5	43.0 N	175.0 E	06	27	40		5 NM	02	1003.0	10.0	10.5	9	24.5			
VAN WARRIOR	LIBERIAN	6	49.4 N	175.5 W	06	32	35		.5 NM	42	993.0	10.0	8.0					
GOLDEN GATE	AMERICAN	6	42.9 N	174.3 W	00	27	40		5 NM	01	1005.1	12.8	8.9	4	10	28	9	18
ROBERTS BANK	LIBERIAN	6	38.1 N	169.6 W	00	23	M 40		2 NM	51	1011.6	20.0	18.3	5	11.5	24	9	16.5
MENEA	SWEDISH	6	44.3 N	163.6 W	18	28	35		10 NM	02	1002.0	11.0	16.0	6	14.5			
PRESIDENT MADISON	AMERICAN	6	44.5 N	157.0 W	18	27	38		10 NM	25	1000.2	11.1	9.4	6	10	25	12	11.5
SEALAND COMMERCE	AMERICAN	7	37.5 N	164.0 W	00	23	35		5 NM	02	1015.4	21.6	16.7	6	10	28	8	8
PRESIDENT MADISON	AMERICAN	7	43.7 N	150.5 W	06	26	35		10 NM	25	1003.5	13.3	11.1	9	11.5	26	9	14.5
MENEA	SWEDISH	7	43.3 N	164.8 W	00	27	35		10 NM	02	1009.0	13.0	16.0	5	5	27	12	13
PRES PIERCE	AMERICAN	9	40.4 N	166.9 E	00	08	35		2 NM	51	1010.2	12.8	12.8	5	5			
THOMAS E CUFFE	AMERICAN	11	35.3 N	142.5 E	06	18	35		10 NM	01	1012.5	23.9	24.4	3	5	23	12	13
GOLDEN GATE	AMERICAN	13	12.0 N	143.2 E	18	32	40	(T)	10 NM	25	1002.4	26.1	25.6	4	5	08	7	11.5
AMER LYNX	AMERICAN	14	14.1 N	149.4 E	00	17	35	(T)	5 NM	02	1004.0	28.3	29.4	2	5	18	7	14.5
THOMAS WASHINGTON	AMERICAN	14	18.7 N	146.0 E	06	11	M 46	(T)	2 NM	80	995.3	27.2	30.6	6	19.5	11	7	29.5
PALSTRIA	DANISH	14	40.4 N	124.6 W	00	01	M 35		2 NM	28	1013.4	16.2		7	10			
GRETE MAERSK	DANISH	14	19.6 N	146.0 E	01	08	60	(T)	5 NM	81	1000.5	27.5	32.0					
GOLDEN GATE	AMERICAN	15	05.3 N	136.6 E	06	24	35		2 NM	81	1006.4	26.6	25.6	6	14.5			
NORILE	AMERICAN	16	54.5 N	139.9 W	00	12	35		2 NM	65	1001.7	10.7	10.6			12	7	10
THOMAS E CUFFE	AMERICAN	18	40.4 N	140.1 W	18	22	35		5 NM	21	1019.6	17.1	15.6	4	6.5	20	< 6	8
CHEVRON PERTH	LIBERIAN	18	09.3 N	131.8 E	06	24	M 35		5 NM	81	1010.0	29.0	30.0	6	13			
ALMIZAR	LIBERIAN	19	50.2 N	138.5 W	00	05	40		2 NM	22	1008.0	10.8	10.0	8	13			
ALEUTIAN DEVELOPER	AMERICAN	19	55.2 N	160.5 W	12	10	M 40		2 NM	21	1013.0	5.5	10.5	3	6.5	20	6	10
VAN CONQUEROR	LIBERIAN	19	48.5 N	141.7 W	12	34	M 37		10 NM	02	1014.0	8.0	12.0					
THOMAS E CUFFE	AMERICAN	20	34.5 N	121.2 W	18	34	35		10 NM	02	1019.0	14.4	15.6	4	10	34	7	11.5
PACIFIC CARRIER	LIBERIAN	20	36.0 N	122.1 W	06	33	35		5 NM	02	1015.0	16.5		4	8	33	6	11.5
CHEVRON WASHINGTON	AMERICAN	20	47.8 N	140.0 W	00	33	35		10 NM	01	1017.5	12.3		6	13	36	12	14.5
BREWSTER	PANAMANIAN	20	52.9 N	145.3 W	06	05	M 36		10 NM	03	1017.0	10.0	10.0			05	< 6	6.5
IDAHO STANDARD	AMERICAN	20	36.2 N	121.9 W	23	33	35		10 NM	01	1015.4	15.0	16.1	3	8	31	7	6.5
VAN CONQUEROR	LIBERIAN	21	48.5 N	139.3 W	12	27	M 38		5 NM	02	1012.0	8.0	11.0					
EASTERN BUILDER	LIBERIAN	24	43.0 N	158.2 W	00	27	M 44		5 NM	02	1013.0	15.0	14.0	6	8			
BREWSTER	PANAMANIAN	26	49.9 N	165.1 E	00	27	M 40		1 NM	05	996.4	10.0	7.0	3	8	27	< 6	14.5
GRAND CARRIER	LIBERIAN	26	49.2 N	146.7 W	18	23	M 35		2 NM	61	1019.0	12.0	9.0					
GRAND CARRIER	LIBERIAN	27	49.2 N	153.4 W	12	23	M 40		.5 NM	25	1017.0	13.0	10.0					
MUNRO	AMERICAN	27	39.7 N	124.8 W	12	33	M 40		5 NM	00		13.6	14.4	12	14.5	29	8	6.5
DISCOVERER	AMERICAN	27	39.9 N	145.9 W	18	07	M 36		5 NM	63	1010.8	12.0	13.0	2	3	09	6	5
SEALAND COMMERCE	AMERICAN	27	48.1 N	177.1 W	12	25	35		10 NM	02	995.0	8.9	6.1	7	13			
GRAND CARRIER	LIBERIAN	28	49.1 N	157.3 W	00	23	M 35		.25 NM	05	1015.3	14.5	9.0					
CAMPBELL	AMERICAN	28	42.2 N	124.9 W	06	36	M 36		5 NM	01	1013.0	14.1	14.5	12	8			
BREWSTER	PANAMANIAN	28	43.6 N	151.8 E	00	20	M 40		< 50 YD	47	1010.4	14.0	14.0	4	8	20	< 6	13
MANDARIN VENTURE	LIBERIAN	31	49.6 N	175.7 W	18	16	M 35		1 NM	63	1017.2	8.2	6.0	9	10			
NORTH PACIFIC OCEAN		AUG.																
GRAND CARRIER	LIBERIAN	2	43.1 N	160.9 E	00	23	M 35		.25 NM	47	1004.0	18.0	12.0					
ALEUTIAN DEVELPPER	AMERICAN	2	56.7 N	154.0 W	06	20	M 35		10 NM	02	1024.5	7.8	9.0	2	6.5	20	6	3
GRAND CARRIER	LIBERIAN	3	38.1 N	148.8 E	18	20	M 45		5 NM	03	999.4	24.0	23.0					
SHIRLEY LYKES	AMERICAN	4	37.4 N	169.0 W	06	20	M 35		5 NM	20	1011.5	22.3	21.1	2	5	20	< 6	6.5
LONG BEACH	AMERICAN	4	14.9 N	97.1 W	12	10	35		5 NM	13	1013.8	27.2	30.0	3	5	18	6	5
HONGKONG PHOENIX	SINGAPORE	4	39.5 N	153.6 E	00	19	40		10 NM	02	1002.2	25.0	24.0	6	13	22	8	13
LAUREL	LIBERIAN	4	43.5 N	154.6 E	12	35	M 43		.5 NM	25	994.0	12.5	16.0					
GRAND CARRIER	LIBERIAN	5	33.2 N	140.4 E	06	24	M 40		10 NM	03	1009.5	30.0	28.0					
NEWARK	AMERICAN	6	49.6 N	128.4 W	18	34	35		10 NM	21	1015.2	12.2	11.7	6	8			
CRESSIDA	PANAMANIAN	7	39.6 N	148.8 E	12	36	M 35		5 NM	02	1003.0	21.5	21.0	6	10			
HONGKONG PHOENIX	SINGAPORE	8	26.3 N	122.9 E	21	02	M 30	(B)	10 NM	02	999.4	28.8	29.0	7	18	11	7	24.5
CRESSIDA	PANAMANIAN	8	40.3 N	151.7 E	00	36	M 49		5 NM	02	1005.0	22.0	20.0	8	13			
AMER LANCER	AMERICAN	9	24.2 N	123.2 E	18	16	30	(B)	5 NM	62	988.0	27.8	27.2	3	10	16	6	24.5
SEALAND FINANCE	AMERICAN	9	22.5 N	121.6 E	18	23	40	(B)	5 NM	03	984.4	27.8	26.7	12	10			
NOPAL FRANCO	NORWEGIAN	9	41.8 N	163.3 E	00	33	36		5 NM	03	1000.0	14.5	17.5	7	14.5	32	11	13
BREWSTER	PANAMANIAN	10	41.3 N	160.3 E	18	08	M 60		2 NM	51	992.0	13.0	14.0	5	13	03	< 6	13
MEADOWBROOK	AMERICAN	10	40.2 N	124.9 W	12	36	35		5 NM	02	1015.9	15.0	14.4	5	10			
LAUREL	LIBERIAN	10	41.6 N	155.6 E	12	10	M 40		.25 NM	53	992.5	16.0	18.0					
LIONS GATE BRIDGE	JAPANESE	10	30.2 N	140.1 W	18	24	M 37		5 NM	03	1006.5	13.0	13.5	8	13			
SEALAND FINANCE	AMERICAN	10	24.1 N	124.2 E	00	16	42	(B)	5 NM	03	996.5	29.4	27.8	9	8	14	9	13

Vessel	Nationality	Date	Position of Ship		Time GMT	Wind			Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C		Sea Waves*		Swell Waves		
			Lat. deg.	Long. deg.		Dir. 10°	Speed kt.					Air	Sea	Period sec.	Height ft.	Dir. 10°	Period sec.*	Height ft.
NORTH PACIFIC OCEAN		AUG.																
PRES MCKINLEY	AMERICAN	10	27.2 N	123.0 E	00	11	50	(B)	5 NM	02	995.9	28.3	28.9	6	19.5			
LAUREL	LIBERIAN	11	42.7 N	157.7 E	00	07	M 37		1 NM	61	987.5	12.5	13.0	6	19.5	08	7	24.5
BREWSTER	PANAMANIAN	11	42.3 N	161.5 E	00	12	M 55		1 NM	50	987.5	13.0	13.0	3	13	10	< 6	16.5
TAI PING	NORWEGIAN	11	32.9 N	170.7 E	18	21	40		5 NM	80	1013.0	26.5	27.0	3	6.5			
WAY WAY	LIBERIAN	11	49.9 N	141.4 W	00	27	M 35		10 NM	50	1010.0	14.0	14.0	7	13			
LAUREL	LIBERIAN	12	42.6 N	163.5 E	00	36	M 38		5 NM	25	992.0	11.0	13.5	6	10	02	11	13
LIONS GATE BRIDGE	JAPANESE	12	51.9 N	156.2 W	00	26	M 36		5 NM	25	1010.5	13.0	13.0	8	13	26	10	16.5
KOK CN	LIBERIAN	12	41.2 N	171.1 E	12	25	40		10 NM	00	1003.5	15.0	15.0					
BREWSTER	PANAMANIAN	12	43.6 N	167.7 E	06	27	M 35		2 NM	10	986.5	10.0	11.0	3	13	27	< 6	16.5
TAI PING	NORWEGIAN	12	31.6 N	165.9 E	12	23	40		5 NM	80	1011.5	25.5	27.0	3	6.5			
WAY WAY	LIBERIAN	12	52.4 N	134.0 W	18	27	M 35		> 25 NM	03	1018.0	14.0	12.0	7	11.5			
SINCERE 3	LIBERIAN	12	47.7 N	171.0 E	00	07	M 37		1 NM	62	994.0	8.9	10.0	8	16.5			
RICE QUEEN	AMERICAN	13	35.2 N	93.6 W	00	20	35		10 NM	03	1010.5	30.6	29.4	3	6.5	25	< 6	13
WAY WAY	LIBERIAN	14	54.4 N	166.9 W	06	20	M 35		10 NM	02	1007.5	10.0	8.0	6	11.5			
PAC EMPEROR	LIBERIAN	14	54.0 N	162.4 W	18	27	35		5 NM	01	1013.0	11.0	9.0	8	8	27	10	19.5
STOLT LION	BRITISH	16	15.8 N	97.9 W	12	13	40		.25 NM	97	1013.9	27.0	30.0			12	< 6	6.5
VAN WARRIOR	LIBERIAN	16	50.4 N	160.6 W	18	24	35		.5 NM	59	1003.0	13.0	11.0	5	16.5	26	8	23
VAN WARRIOR	LIBERIAN	18	49.5 N	172.1 W	06	26	35		10 NM	50	1003.0	13.0	11.0	5	13	26	8	16.5
WAY WAY	LIBERIAN	20	38.9 N	143.4 E	18	11	M 35		2 NM	61	1011.0	22.0	23.0	6	10			
METSHU MARU	JAPANESE	25	50.2 N	158.1 W	18	25	M 38		.5 NM	62	991.8	11.5	11.0	5	6.5			
PRES TRUMAN	AMERICAN	26	54.1 N	152.3 W	12	27	38		1 NM	80	985.5	11.1	10.6	7	10			
PRES TAFT	AMERICAN	26	49.9 N	154.4 W	06	27	35		5 NM	02	1010.0	12.2	9.4	7	10	09	6	13
PRES MCKINLEY	AMERICAN	26	47.3 N	163.0 W	00	27	35		5 NM	02	1009.2	12.2	11.1	3	6.5	27	7	13
PORTLAND	AMERICAN	26	57.2 N	150.4 W	06	09	35		1 NM	53	988.8	10.0	8.9	7	8	12	6	16.5
HONGKONG PHOENIX	SINGAPORE	26	49.9 N	148.6 W	06	25	38		10 NM	02	1001.0	10.7	12.0	7	18	26	8	19.5
IDAHO STANDARD	AMERICAN	26	59.8 N	148.3 W	18	09	40		5 NM	60	995.0	12.2	13.9	3	6.5	09	< 6	13
GOLDEN MARINER	PANAMANIAN	26	52.6 N	165.6 W	18	26	M 35		> 25 NM	02	1000.2	21.0	11.0	5	6.5	26	7	11.5
ALEUTIAN DEVELOPER	AMERICAN	26	59.5 N	149.0 W	21	08	M 70		2 NM	07	992.0	7.7	13.4	2	10	08	< 6	19.5
METSHU MARU	JAPANESE	26	50.5 N	155.2 W	00	25	M 40		.5 NM	21	992.5	11.0	10.5	4	6.5	24	6	13
GOLDEN MARINER	PANAMANIAN	27	52.3 N	167.2 W	00	28	M 38		> 25 NM	01	1002.4	14.0	11.0	5	6.5	26	7	14.5
ALEUTIAN DEVELOPER	AMERICAN	27	59.0 N	149.6 W	00	09	M 50		2 NM	07	990.5	7.7	13.4	2	10	09	< 6	21
SINCERE 3	LIBERIAN	31	53.5 N	178.1 W	00	27	M 35		5 NM	02	995.0	9.5	8.0	5	10			
ALEUTIAN DEVELOPER	AMERICAN	31	54.2 N	166.7 W	06	18	M 50		5 NM	25	1000.0	6.5	6.5	2	6.5	18	6	16.5

\+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind
(B) Typhoon Ruby
(S) Typhoon Sally
(T) Supertyphoon Therese
(B) Supertyphoon Billie

NOTE: The observations are selected from those with winds ≥ 25 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

Rough Log, North Atlantic Weather

October and November 1976

ROUGH LOG, OCTOBER 1976--The majority of the significant cyclones occurred during the second half of the month. There were two primary cyclone tracks that affected shipping. One was from the Gulf of St. Lawrence to south of Iceland; the second was from off the east coast of the United States to northern Europe. These closely approximated the climatological tracks. There were secondary tracks over the Labrador Sea and off the west coast of Europe.

The mean monthly pressure centers were near their climatological counterparts, but the central pressures were more intense than the climatic mean. The Icelandic Low was 992 mb versus the climatic mean of 1001 mb near 61°N, 30°W. The Azores High at 1024 mb versus 1019 mb according to long-term climatology, was near 32°N, 34°W. There were isolated high-pressure centers over the eastern United States. A 1026-mb High was centered north of the Black Sea with a pronounced trough oriented northwest-southeast across France into the Mediterranean.

There were two large departure-from-normal centers. The most significant for the majority of ships was the minus 12-mb center over Lands End. This was a reflection of the trough mentioned earlier. A large 14-mb positive anomaly center was near Nordkapp, Norway. This was associated with a ridge from the High north of the Black Sea. The higher pressure of the Azores High resulted in a positive 5-mb center near 31°N, 32°W. The triangle of ocean bounded by the east coast of North America, north to Newfoundland, and south along 50°W, was within 1 mb of the long-term mean.

The upper air at 700 mb was mainly zonal over the major shipping lanes. A Low was centered east of Kap Farvel with a moderate trough along the Appalachian Mountains and a sharp trough from the LOW across Ireland and France.

Hurricane Holly formed during the last week of the month.

Extratropical Cyclones--The first storms of the month were not as intense as those which came later. The circulations did not develop as large as they broke up into multiple centers.

This storm originated as a frontal wave south of Newfoundland on the 3d and traveled around the outskirts of a LOW centered near Iceland. It was not until after 0000 on the 5th that the isobars on the weather chart indicated a closed circulation. At that time the ILLYRIC, near 44°N, 16°W, reported 20-ft swells. At 1200 the TILLIE LYKES was 850 mi southwest of the 972-mb center with 23-ft swells. The Ocean Weather Station C7R was tossed by 26-ft waves. At 0000 on the 6th, the ODIN DRILL, at 58.7°N, 01.2°E, in the North Sea, recorded 52-kn winds. At 0600 the ANCHISES was west of the Irish coast and had 44-kn winds and 26-ft swells. At 1200 the LOW was 960 mb near 59°N, 13°W (fig. 28). Many ships throughout the

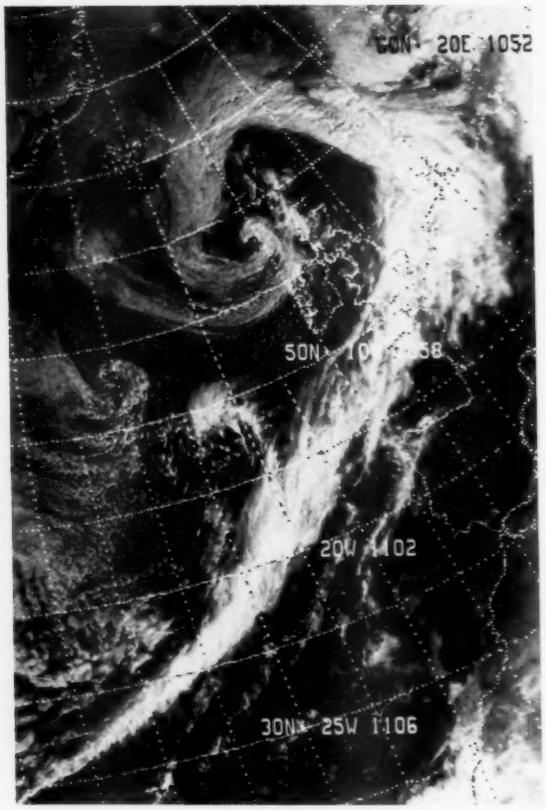

Figure 28.--A sharp cold front extends far south of the LOW. The clouds associated with the peripheral LOWs are near 50°N, 20°W, and 53°N, 30°W.

area south and east of Iceland were reporting high winds and seas. The CAPE NELSON fought to stay afloat at 55.6°N, 7.8°W, in 52-kn winds, 23-ft seas, and 49-ft swells.

In the meantime, two peripheral LOWs had formed south and west of the center. As they rotated eastward, the pressure gradient tightened south of their centers with resulting high winds and waves. At 0000 on the 7th, the HANNOVER, far west near 51°N, 43°W, contended with 36-ft swells.

By the 8th the storm was moving over the Greenland Sea to dissipate over the cold water.

A LOW was moving northeastward over the Labrador Sea late on the 7th. The point of occlusion of the associated front passed slightly south of Kap Farvel, and the 0000 chart of the 8th showed a closed circulation around that point east of the cape. The center moved northeastward into the Denmark Strait. At 0000 on the 9th, the weather station on the Ice Cap, near 65°N, 43°W, reported roaring, 60-kn winds and heavy fog.

At 1200 the METEOR (53°N, 37°W) was tossed by 25-ft seas, and the MINDEN (63°N, 23°W) reported hurricane-force, 78-kn winds. At 0000 on the 10th, the LOW was still in the same area (near 62°N, 30°W) at 971 mb pressure. At 0600 three ships south of the center reported seas or swells between 23 and 28 ft.

By the 11th the LOW was filling as other LOWs approached from the west and southeast. On the 12th the LOW started slowly sliding northward and disappeared.

This storm center remained over land, but its effects were felt by coastal ships as it moved over the Atlantic States. On the 8th a front lay along the Appalachian Mountains, and a wave formed near Plains, Ga. The LOW moved northeastward along the eastern slope of the mountains. Heavy rains and severe weather accompanied the storm. Five tornadoes were reported in North Carolina and Virginia. Gale warnings were posted for much of the East Coast. Thunderstorm winds gusted to 74 kn at Elizabeth City, N.C.; 70 kn near Dulles Airport in Virginia; and 51 kn at Cape Hatteras, N.C. Gusts of 45 kn were reported through eastern Maryland and Pennsylvania. A 63-ft wood sailboat JUSTUS sprang a leak and sank off New Jersey. The Coast Guard and the ASTRALITA rescued those aboard. By 0000 on the 10th, the 982-mb center was over northern Vermont. The strong winds and high waves were well south of the center. The S.A. MORGENSTER, at 38.3°N, 68.3°W, recorded 62-kn winds from the south just ahead of the front. The swells were 25 ft. At 1200 the WILMINGTON GETTY reported 76-kn westerlies behind the front off Cape Cod (fig. 29). Serious flooding occurred with the heavy rains along much of the East Coast from South Carolina northward.

Early on the 11th, the VGBZ measured 50-kn westerlies south of Sable Island. By 1200 the LOW had split into two centers, and the new one east of Newfoundland treated the QUEEN ELIZABETH 2 to 13-ft seas and 20-ft swells. By the 12th both centers had disappeared.

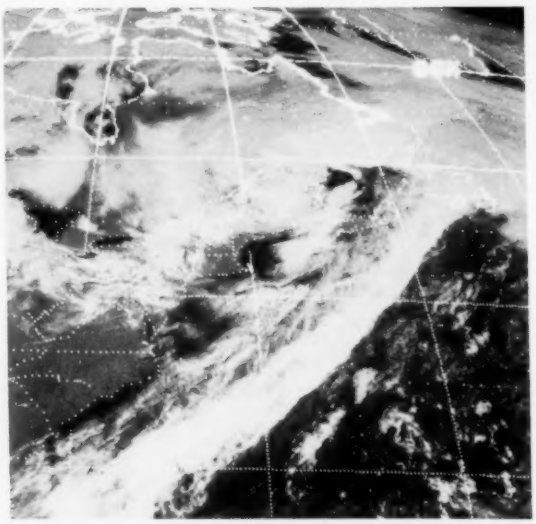

Figure 29.--At 1700, the LOW is over the Gulf of St. Lawrence. Instability behind the front is indicated by the cumulus-type clouds.

Monster of the Month--This storm formed as a frontal wave in midocean near 49°N, 37°W, at 1800 on the 12th. It quickly deepened, drawing circulation from a LOW near Iceland. At 1800 on the 13th, the SHACKLETON was near 49.1°N, 15.1°W, about 100 mi southwest of the center, with 55-kn winds and 23-ft seas.

At 0000 on the 14th, the 976-mb LOW was near Fastnet Rock. There was little gradient north of the center, but to the south and west there was a strong gradient. South of the center the ARMADALE found 70-kn westerlies. The JOHN MURRAY in St. Georges Channel fought 60-kn winds. Ocean Weather Station Romeo had only 35 kn at observation time with 18-ft seas. The AMERICAN ACE had departed Le Havre and was in the English Channel at about 0200 when she must have passed almost directly through the center of the LOW. Her barograph (fig. 30) indicated 964

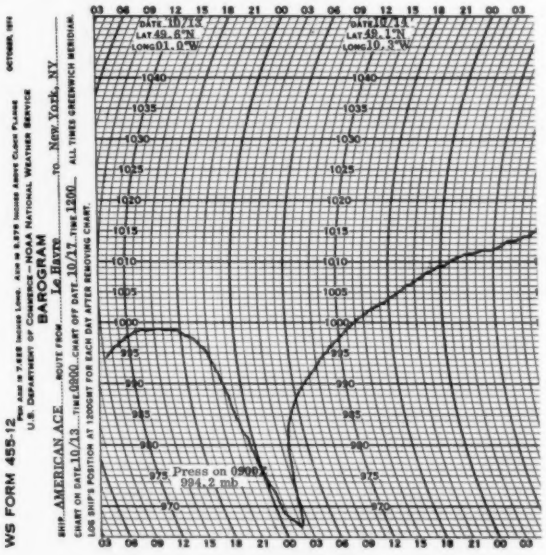

Figure 30.--The barogram from the AMERICAN ACE.

mb, which was lower than the pressures indicated on either the 0000 or the 0600 charts. At 0600 the STRATHAIRD in the Bay of Biscay logged 50-kn winds from the west with 25-ft swells. At 1200 the ATLANTIC COGNAC (49.9°N, 03.2°W) was bounced by 33-ft waves

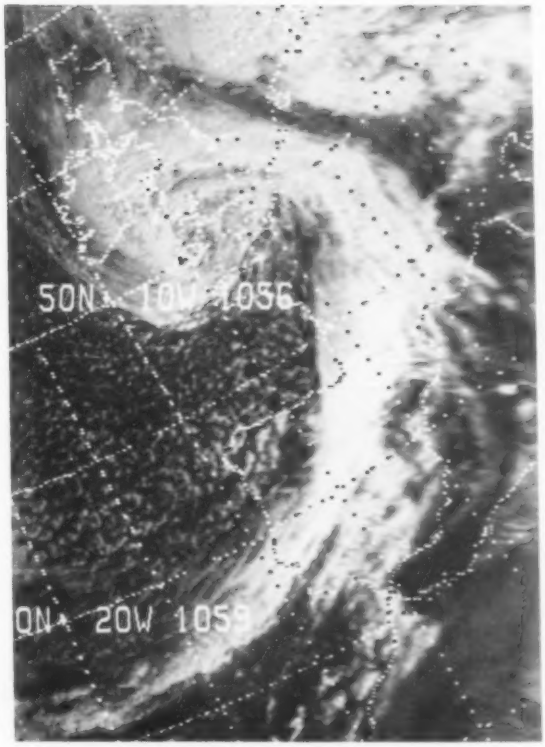

Figure 31.--At 1056 on the 14th, the satellite image indicates the storm's center is slightly north of the English Channel.

driven by 50-kn winds (fig. 31). One ship sank and two went aground during this storm. The 7,644-ton East German tanker BOHLEN sank off the Brittany coast. Eleven crewmembers were rescued and 25 were missing. The 115,135-ton Liberian tanker ANDROS ANTARES went aground in 60-kn winds at Le Havre after breaking her lines. Six tugs freed the vessel at high tide on the 15th. A 10,287-ton Swedish motor vessel went aground near Stockholm. There was no indication that high winds were involved.

By 0000 on the 15th, the chart showed the 976-mb LOW to be over central England. The OLENEGORSK battled 66-kn winds and 33-ft seas at 49.8°N, 05.6°W. The LOW was turning northward over the North Sea and weakening, but ships were still reporting winds in the 50-kn and seas in the 20-ft range. Early on the 16th, the closed circulation was absorbed by another LOW.

This low-pressure circulation was first detected on the 16th south of Louisiana over the Gulf of Mexico by reports from two buoys. A cold front moved south off the Gulf Coast and was incorporated into the LOW on the 17th as it moved eastward. On the 18th the LOW raced northeastward off the U.S. East Coast. At 1200 it was 992 mb near 42°N, 64°W, with gale-force winds. At 0000 on the 19th, the DART AMERICA (43°N, 61°W) was plowing into 55-kn winds and 23-ft

waves. At 0600 the ANCO STANE was pounded by 50-kn winds and 30-ft swells on her port side. At 1200 the BESSTRASHNIJ, north of Newfoundland at 52°N, 54°W, suffered 66-kn winds and 30-ft seas out of the north. The LOW was 964 mb near 51°N, 51°W. The DLHO reported 60-kn winds and 33-ft seas south of the center at 1800 on the 19th and 0000 on the 20th. The C.P. VOYAGEUR was battered by 36-ft swells near 53°N, 26°W. The 1,200-ton Dutch freighter GABRIELLA sank about 60 mi southwest of Newfoundland. Only 2 of 15 crewmembers survived after abandoning ship. Seven bodies were found on a raft which washed ashore on Newfoundland.

High seas and swells were occurring over a wide area south of the center. At 1200 on the 20th, the VOYAGEUR was at 33°W with 47-kn winds from 280°, and the swell was now 41 ft. The C.V. LIGHTNING (49°N, 29.7°W), 500 mi south of the center, was headed into 55-kn winds and 30-ft swells. At 1800 Ocean Weather Station C7C measured 46-kn winds and 31-ft seas. Waves of near 30 ft continued through 1800 on the 22d. At 1200 on the 21st (fig. 32), the LOW was 969 mb near 59°N, 25°W. A ship near 50°N, 20°W, reported towering 43-ft swells. The LOW stalled at this position for about 24 hr before taking a southeasterly track. Waves of 20 to 30 ft were relatively common on the chart.

As the storm tracked southeastward, it was filling and weakening, but high swells were still reported. Early on the 24th, it was absorbed by another LOW off Cabo Finisterre.

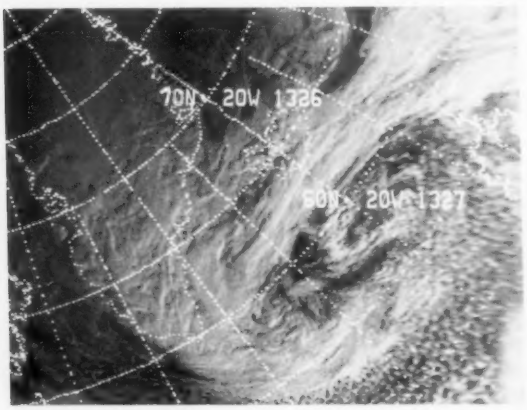

Figure 32.--Satellite imagery indicates there may have been more than one center.

With the formation of this LOW there were four in a line north to south along approximately 20°W. This one was the third from the north near 51°N, 22°W, at 0000 on the 26th. The center moved northward as the next one to the north disappeared. Gales were starting to blow. Late on the 26th the LOW reached its northernmost point, curved westward, then turned southeastward. At 0000 on the 27th, Ocean Weather Station C7R measured 35-kn winds and 20-ft seas. At 1200 the ANTILLA CAPE (46°N, 19°W) found 50-kn winds and 30-ft seas about 150 mi from the center. The BUNTENTOR fought 50-kn winds and 30-ft seas at 1800. As the LOW moved over Cabo Finisterre, 50-kn winds and waves to 30 ft were still being reported on the 28th. At 1200 the BORDER SHEPHERD, north of the center at 46.6°N, 7.7°W, had easterly 37-kn winds, 8-ft seas, but crushing 33-ft swells. Early on the 30th, only a weak 1004-mb center could be found near Gibraltar, and that no longer existed by the next chart.

It was only near the end of its career that this storm was significant. It started as a frontal wave on the 28th midway between Bermuda and Cape Hatteras. It raced northeastward with the usual gale and wave reports. On the 1200 chart of the 29th, a new frontal wave developed on the front northeast of this one. It only survived for two synoptic charts, but at 1200 the AMERICAN ALLIANCE (44.7°N, 34.5°W), west of the center, was hit by 64-kn northerly winds with 15-ft seas and swells. The LOW continued northeastward with little change in intensity. By 1200 on the 31st, it was 972 mb near 57°N, 20°W. On November 1, it stalled just south of Iceland and at 1200 was 960 mb. The winds were increasing, and C7L measured 50-kn winds and 23-ft waves. On the 2d the winds were still 50 kn and the waves 25 ft. Later that same day, the LOW started drifting eastward. Waves of about 25 ft were being reported as far south as 50°N; the winds were in the 40-kn gale category. At 0000 on the 3d, the STADT ELSFLETH was sailing westward into 26-ft swells near 52°N, 16°W. The winds were only 30 kn and the seas 10 ft. The storm dissipated on the 4th.

This storm came out of the northwestern Gulf of Mexico. It was first detected on the weather charts on the 29th. It moved northeastward to the Great Lakes and along the St. Lawrence River. The central pressure was 990 mb over the Gulf of St. Lawrence at 1200 on November 1. The storm gained strength as it moved over the Labrador Basin, and the first gales were reported on the 3d. By 1200 it was 972 mb near 56°N, 43°W. The JOHN CABOT was north of St. John's (51°N, 50°W) with 55-kn winds. At 1800 the POLARNYE ZORI was blasted by 70-kn winds from the west and 25-ft seas.

At 0000 on the 4th, the LOW was centered about 400 mi north of Ocean Weather Station Charlie, which was tossed by 50-kn winds and 26-ft seas. At 0600 the winds had decreased to 46 kn, but the waves were now 31 ft (fig. 33). The MAI in the Denmark Strait suffered 60-kn northeasterly winds with heavy rain. On the 1200 chart, there were reports of 40- to 50-kn winds south and west of the center. The WESER EXPRESS was headed into only 40-kn winds, but the seas and swells were 33 ft near 57°N, 29°W. At 1800 the swells were 43 ft.

On the 5th the high seas and swells extended as far south as OWS C7R, which measured 26 ft as did C7C southwest of the center. By the 7th, the LOW was weakening as it moved toward the continent.

Tropical Cyclones--A relatively weak tropical wave moved westward off the African coast on October 14. It was not until the 20th that satellite pictures revealed a concentrated area of cloudiness centered near 18°N, 50°W. At that time there was no evidence of a closed circulation at the surface. The system gradually became better organized, and by the 22d a depression

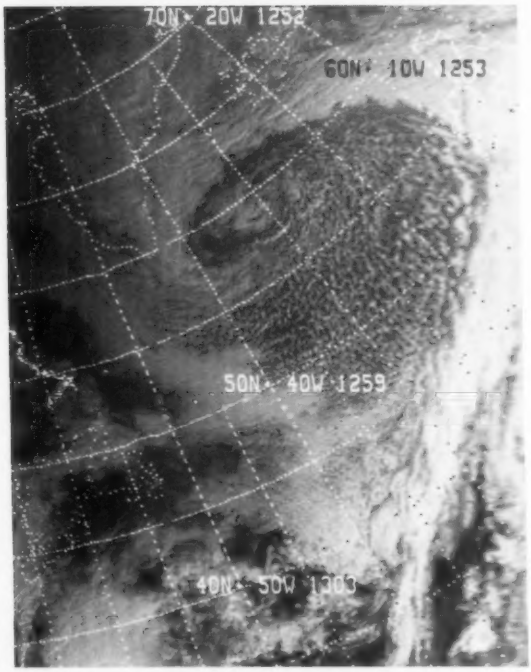

Figure 33.--The storms near and above 60°N are not well illuminated on the visual because of the low Sun angle.

had formed, centered near 19.1°N, 55.8°W. It moved northwestward at 10 kn, intensified to tropical storm Holly on the 23d, and reached minimal hurricane strength the following day. This intensity was maintained only for 24 hr, after which it dropped back to tropical storm strength until the storm lost its identity as it merged with a strong cold front over the North Atlantic on the 28th. Holly's lowest pressure was 990 mb on October 24, and the highest wind reported by reconnaissance aircraft was 65 kn on the same day.

Casualties--The 5,713-ton Norwegian freighter RYTTERHOLM sank during a storm at the entrance to La Coruna Bay. The vessel was carrying a cargo of fertilizer which shifted during the storm. Efforts by tug boats to assist failed. No date was indicated. The 15,028-ton Panamanian-registered SYLVIA L. OSSA apparently sank about 140 mi west of Bermuda on the 13th. No distress message was heard after the ship radioed the owner that it was reducing speed due to gale-force winds and high seas. Weather reports indicated winds of 40 kn and seas of 12 ft in the area. U.S. Coast Guard and Navy planes searched the area, but no survivors were spotted. A British ship picked up a burned life preserver, and another ship found a lifeboat whose quick-release mechanism had not been tripped. The British motor vessel ALBAN bound for Barbados sustained heavy weather damage and loss of some containers. The 78-ft trawler LANA CAROL sank with a full load of scallops off Barnegat Light on the 31st. The four crewmen were rescued by Coast Guard helicopters and a rescue ship.

ROUGH LOG, NOVEMBER 1976--This was a rough month for ships, especially over the western part of the ocean. The area off the east coast of the United States was the favorite area of cyclogenesis and tracks. The main concentration was from near Cape Hatteras to east of Cape Race. Off Cape Race approximately half curved north-northwestward toward Greenland and the Labrador Sea, while the other half continued northeastward following the climatological path toward Iceland.

The monthly mean pressures were more intense than the long-term mean. The Icelandic Low consisted of two centers as climatology indicates, but they were shifted many miles southwestward and deeper. The climatic positions are near 61°N, 30°W, (1003 mb), and 68°N, 00°W (1005 mb). This month they were near 56°N, 52°W, at 997 mb and 61°N, 30°W, at 998 mb. The Azores High was shifted in the opposite direction--northeastward. It was 1024 mb near 39°N, 19°W, versus the climatic 1019 mb near 35°N, 32°W.

There were two major anomaly centers. The largest, a negative 13 mb, was centered over Belle Isle. Its influence was felt from the northeastern United States to Scotland and Norway. The other center was plus 7 mb off Lisbon near 39°N, 14°W. This area was shaped like a large right foot with the center corresponding to the ball of the foot. The heel would be near 25°N, 55°W.

The 700-mb, upper-air gradient was much more intense with higher winds. This was partially due to an anomalous LOW near Hopedale on the Labrador coast of Canada. The trough was slightly west of and parallel to the east coast of the United States. There was slight ridging off the European coast with another trough over central Europe. There were a large negative anomaly centered off the Strait of Belle Isle and a positive anomaly that stretched southwestward from northwestern Spain.

There were no tropical cyclones this month.

Extratropical Cyclones--The first severe storm of the month formed near Norfolk, Va., at 1200 on the 5th. Twenty-four hours later, it was 986 mb over Nova Scotia. At 1800 (fig. 34) the SEA-LAND CON-

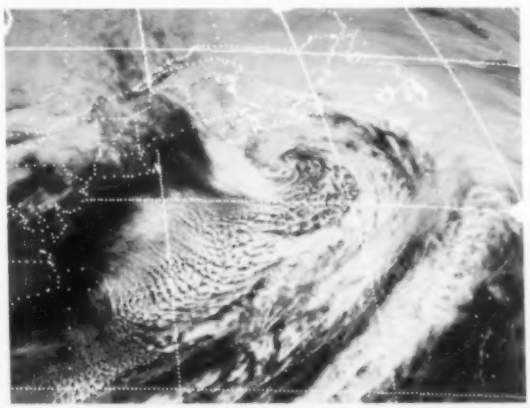

Figure 34.--The cumulus cloud streaks indicate unstable weather.

SUMER, at 39.2°N, 57.5°W, encountered 41-ft swells. The drilling ship VGBZ fought 52-kn winds and 26-ft swells. The central pressure was plummeting. At 0000 on the 7th, it was 956 mb between Newfoundland and Anticosti Island. There were strong winds all around the storm, but especially in the northeastern quadrant. The JOHN CABOT (51°N, 50°W) and the POLARNYE ZORI (52°N, 55°W) both reported howling 60-kn winds from the east-southeast. The VGBZ (43.5°N, 60.4°W) suffered 50-kn winds, 10-ft seas, and 44-ft swells.

By 1200 the pressure had risen slightly, but this did not help the SEA-LAND COMMERCE (40°N, 49°W) with 41-ft swells. A SHIP at 58.3°N, 58.6°W, reported 56-kn winds. The LOW was traveling along the Labrador coast. At 0000 on the 8th, 65-kn winds were observed by a SHIP at 56.8°N, 56.9°W, with 25-ft waves. On the 9th the LOW was south of Ungava Bay and only affecting those ships that braved the cold water of the Labrador Sea.

This storm formed in one of the favorite areas for cyclogenesis--off Cape Hatteras. The first analysis of the 1200 chart on the 8th showed a well developed frontal wave (fig. 35). The DAWSON was at 40.4°N, 55.4°W, with 50-kn southwesterly winds. At 0000 on the 9th, the ALERT experienced 60-kn winds near 42°N, 65°W.

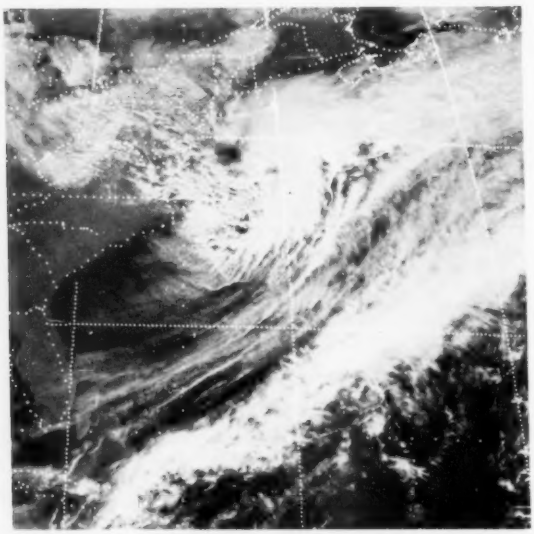

Figure 35.--The stationary satellite is an invaluable aid in quickly identifying fast-developing storms in this area.

The storm was following the same track as the previous storm, only slightly eastward. At 1200 the LOW was 963 mb on the south coast of Newfoundland. A ship, south of St. Mary's Bay at 45.7°N, 55.6°W, was tossed by 65-kn winds and 26-ft seas. Another fought 60-kn easterly winds north of St. John's. By 1800 the winds had shifted to the southwest at 66 kn driving 25-ft seas. The ANTON DOHRN was battered by 33-ft seas near 46°N, 56°W.

At 0000 on the 10th, the 955-mb LOW was near 53°N, 55°W. The JOHN CABOT, near 51°N, 48°W, held her bow into 65-kn winds. By 1200 the winds were only 50 kn, but the swells had increased to 36 ft. There were several coastal and ship reports of 40 kn and waves of 20 to 25 ft. At 1800 the CABOT's swell report was 39 ft.

On the 11th, the storm turned westward and then southward as it weakened. At 0000 on the 12th, the pressure had risen to 978 mb. Later in the day the storm disappeared from the analysis.

As the previous storm moved northward, an area of low pressure moved out of New England, and a LOW developed near Sable Island late on the 10th. The LOW tracked northeastward as the other LOW turned to the west, then back to the south. A SHIP near 40°N, 55°W, reported 45-kn gales. The VGBZ measured 50-kn winds well southwest of the center at 0000 on the 12th. At 1800 the ERLANGEN was over 900 mi south of the storm with 60-kn winds as a trough line passed. At 0000 on the 13th, the 962-mb LOW was near 58°N, 39°W. The ANNA JOHANNE, just south of Kap Farvel, had 60-kn winds, a thunderstorm, and 26-ft waves. A ship just southeast of the center had 45-kn winds and 20-ft waves. The DART AMERICA was far south at 45°N, 38°W, with 50-kn westerlies and 23-ft waves. The SEA-LAND ECONOMY was even farther south near 29°N, 40°W. The report read calm winds and no seas, but the swell was 39 ft. This could possibly have been an erroneous report, or the high swell could have been propagated from the several severe storms to the northwest in a short period of time. At 1200 the strong winds had moved as far east as the Irish coast as attested to by the 56-kn report at 51.4°N, 18.9°W, by the CASUARINA. By the 14th a new LOW moved in from the south and took over the circulation.

In approximately 6 days this storm traveled from the balmy Gulf of Mexico to northern Greenland. It started in an inverted trough over the Gulf of Mexico late on the 13th. A large, cold HIGH was centered over Missouri. The trough moved eastward, and by 0000 on the 16th, gained strength as it moved past Cape Hatteras. At 1200 on the 17th, the LOW was 966 mb near 48°N, 45°W. The ATLANTIC CHAMPAGNE (47.5°N, 43°W) was pounded by 60-kn winds and 25-ft seas with a pressure of 970.5 mb within a few miles of the center. Ships were reporting 40- to 45-kn gales on both sides of the front south to nearly 30°N. Six hours later the CITY OF DUNDEE found 31-ft swells near 50°N, 44°W.

As the storm approached the southern tip of Greenland on the 18th, it turned westward and moved up the west coast of Greenland. The front extended south-southeastward carrying the circulation as far south as 25°N in a sharp trough (fig. 36). It was the major circulation system between Europe and North America. At 1200 the BERNES, near 59°N, 23°W, was headed eastward with 60-kn southerly winds and being beaten by 44-ft seas and 39-ft swells. On the 19th, another LOW developed on the front on the east coast of Greenland as the original LOW dissipated near Thule.

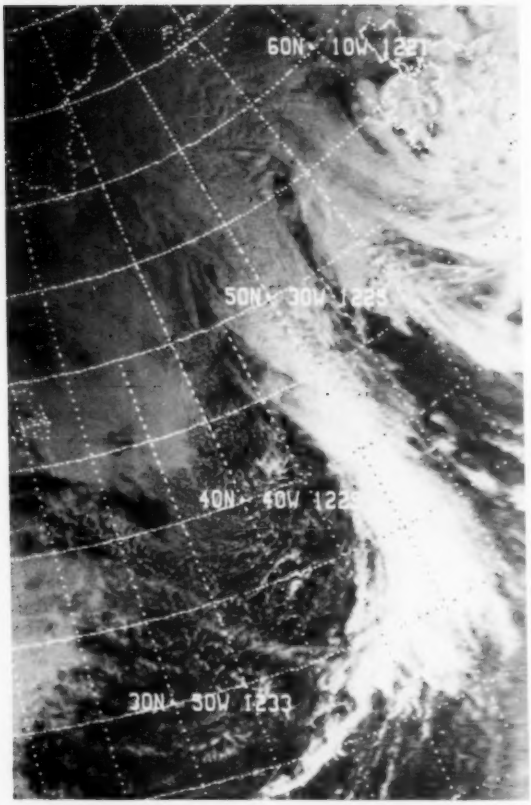

Figure 36.--The trough and front extend north-south along 30°W.

A trough formed off the coast of New England on the 18th. By 0000 on the 19th, it had moved eastward to near longitude 60°W, and a deep, 976-mb LOW developed near 42°N, 60°W. The GREEN LAKE (33°N, 52°W) had 60-kn winds. At 0600 the DJATIPURA had 63-kn southeasterly winds and 33-ft swells on her port quarter near 36.6°N, 52.4°W. The VGBZ (43°N, 62.2°W) on the other side of the LOW was endangered by 68-kn northwesterly winds. The waves were only 16 ft. There were several 40- to 50-kn winds. At 1200 there were seven reports of winds 50 to 63 kn. Among these, the GREEN WAVE plowed into 41-ft swells at 33°N, 56°W. The GPZU (44.8°N, 52°W) reported howling, 94-kn winds at 1800. There were four reports of swells over 30 ft.

On the 20th, the 968-mb LOW was over the Gulf of St. Lawrence and moving northwestward. High winds and seas were continuing. By the 21st, the LOW had moved inland and the windspeeds had decreased to about 45 kn. VGBZ and CG11 both reported 33-ft swells south of Newfoundland.

On the 22d a frontal wave developed south of the LOW and moved around the eastern perimeter. On the 24th it became a major cyclone.

Monster of the Month--A long, relatively straight northeast-southwest oriented front stretched from the western Gulf of Mexico to the mid-Atlantic on the 28th (fig. 37). Frontal waves had been forming and dissipating along the front. On the 1200 chart one was analyzed over the southern end of the Appalachian Mountains. This wave was able to maintain its identity and grow as it raced northeastward. On the 29th the front extended to the English Channel. Ocean Weather Station Romeo measured 36-ft seas. The upper-air flow was zonal from the central United States to the west coast of Europe. The long fetch of westerly winds resulted in high seas and swell all along the front, especially south of it.

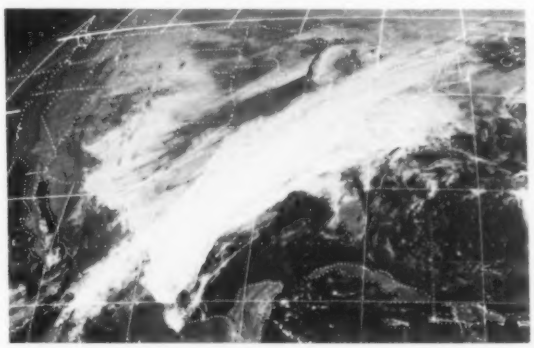

Figure 37.--A broad area of clouds associated with the front covers the United States from Texas to New England.

At 1200 on the 30th, the LOW was 983 mb near 54°N, 45°W. The FROSTFJORD had fought 68-kn winds near 44°N, 30°W, at 0600. Romeo was being tossed by 36-ft seas again. The CIROLANA was sailing with 43-ft swells on her stern at 45.9°N, 17.5°W, and Romeo was fighting to stay on station with 33-ft seas. On December 1, a band of 40-kn winds could be analyzed from Newfoundland to Ireland. At 0600 Charlie measured 54-kn westerly winds and 26-ft seas. By 1200 the 970-mb LOW had raced to 55°N, 14°W (fig. 38). Three ships in the vicinity of 51°N, 22°W, reported winds over 50 kn. Romeo had 30-ft seas and the PHILOSOPHER (46°N, 11.2°W) had 33-ft swells. At 1800 the FROSTFJORD's report at 47.8°N, 15.6°W, read an outstanding 100 kn. The ATLAN-

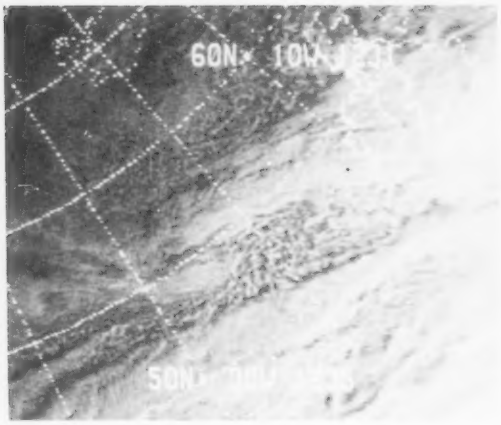

Figure 38.--There is only a slight indication (54°N, 26°W) in the high clouds of the intense low-level circulation.

TICA MARSEILLE off Lands End had 70 kn, and a nearby ship reported 36-ft swells. At 0000 on the 2d, Romeo was now being bruised by 39-ft seas. Charlie had 26-ft seas. The Liberian tanker ENERGY VITALITY ran aground in Jade Bay near Wilhelmshaven.

As the LOWs moved into the North Sea, they turned northward and were absorbed into a large, multicentered LOW that dominated the North Sea. The cyclonic circulation of this huge system stretched from Spitsbergen to North Africa and Greenland to Moskva. The high winds and seas still continued from the Labrador Sea to the Bay of Biscay. On the 2d, the high winds pushed across Spain and France into the Mediterranean Sea. At 1200 three ships reported 50-kn winds and waves up to 33 ft between Algeria and France. At 1800 the UDKF was pounded by 60-kn winds and 20-ft seas east of Gibraltar. On December 3, the 75,000-ton tanker BEN FRANKLIN (fig. 39) broke its mooring in Marseilles harbor, crushed the oil research ship FRANCESCA, and went aground. The 12 crewmembers on the FRANCESCA were rescued.

There were still strong winds and heavy seas upstream as OWS Charlie still contended with 25-ft seas. The 3FEP had 60-kn winds and 33-ft seas only a few miles off the north coast of Spain. Five other ships in the Bay of Biscay reported waves over 30 ft. The MONTE ROTONDO in the Ligurian Sea fought 55-kn winds.

On the 4th, the LOW consolidated into one 970-mb center over the Skagerrak and a frontal wave over the Adriatic Sea. The gradient around the main LOW had relaxed, but it was still tight between 40° and 50°N west of France and Spain where the winds were 35 to 45 kn and the waves about 25 ft. On the 5th, the LOW moved into the Barents Sea.

Figure 39.--The bow of the BEN FRANKLIN towers over the broken FRANCESCA.

Casualties--Fire broke out in the engineroom of the 11,500-ton SEATTLE on the 7th about 1,400 mi east of New York. Twenty crewmen abandoned ship and stood by in lifeboats riding 12-ft swells on 6-ft seas, while the remaining crew fought and controlled the fire. The USCGC TANEY rescued three persons from a sinking shrimp boat about 250 mi northeast of Norfolk, Va. The shrimp boat was taking on water in 18- to 20-ft seas. The 8,461-ton RUPSA and the 13,359-ton AGELOS RAPHAEL collided on the fogbound St. Lawrence River.

On the 13th, the 11,144-ton OCEAN SOVEREIGN was pushed out of line with the Soo Locks by 30-kn wind gusts and jammed the approach channel. Traffic was interrupted for 8 hr until tugs straightened the vessel. The 699-ton MERCANDIAN SUPPLIER arrived Brest on the 14th with cargo shifted and deckload partly washed overboard.

The 48,629-ton tanker SOUTHERN SUN ran aground in Zuetina Harbor, Libya, during 40-kn winds.

Rough Log, North Pacific Weather

October and November 1976

ROUGH LOG, OCTOBER 1976--The cyclone tracks this month were slightly below normal in number. Over the western ocean they followed the normal climatological paths except for a slight grouping near the northern tip of Sakhalin Island as the result of two Sea of Japan storms that tracked northward into that area. There was also a crowding of storm paths in the vicinity of Adak Island as storms approached from the west to the south. There were fewer storms in the Gulf of Alaska than normal. The storms that normally originate near midocean and track northeastward into the Gulf originated farther east and south this month and tracked toward British Columbia.

The pressure pattern closely resembled the long-term mean except for some slight shifting of centers. The Aleutian Low matched the climatic mean of 1001 mb pressure, but it was centered near the Fox Islands rather than slightly northeast of Kodiak Island. There was an anomalous 1007-mb Low center over the Sea of Okhotsk. The large Pacific High closely matched its climatological counterpart with two centers. There was a 1020-mb center near the normal 1019-mb center of maximum pressure near the central ocean. A 1021-mb center that was 2 mb higher than normal was northeast of its counterpart and near 39°N, 133°W.

The primary anomaly centers were alined east-west across the northern ocean near 50°N. A 6-mb negative center was over the Sea of Okhotsk, and another 6-mb negative center was near 50°N, 175°W. A positive 7-mb center completed the alinement south of Sitka.

The upper-air pattern and wind flow were more intense than normal. A closed Low center replaced the normal trough over the eastern Bering Sea. A pronounced ridge separated that Low center from another over the Sea of Okhotsk. The ridge over the Rocky Mountains was higher than normal. The anomaly centers matched the surface centers in both location and pressure differences from the climatic normal.

There were only two tropical cyclones this month--tropical storm Naomi over the eastern waters and typhoon Louise over the western ocean.

Extratropical Cyclones--This frontal wave first appeared on the 0000 chart of the 3d near 38°N, 167°E. It traveled eastward at about 35 kn under the upper-air zonal flow and started deepening on the 4th. Late that day it turned northeastward. At 1800 on the 5th, the VAN TRIUMPH was about 120 mi east of the center with 64-kn southerly winds. At 0000 on the 6th, the 972-mb center was near 50°N, 150°W. At 0600 the TEKHNOLOG, at 53.3°N, 148°W, was very near the center fighting 58-kn winds from the south and 21-ft seas. On the 7th the storm moved ashore near Valdez.

This storm closely followed the climatological storm track that extends from south of Japan into the Bering Sea. It was first analyzed at 0000 on the 9th. By 0000 on the 11th, it was a large storm moving northeastward east of the Kuril Islands (fig. 40). At that time it was 978 mb near 43°N, 153°E. The PRINSENDAM was within 30 mi of the center with the barometer reading 980 mb. The winds were not exceptionally strong, but the seas were 16 ft. What hurt were the 46-ft swells that were pounding the ship. The YANA was west of the center with 52-kn winds, and the MEISHUN MARU was north of the center with 55 kn. At 0600 the GIBRALTAR MARU (39°N, 161.6°E) had 33-ft swells. At 1200 another ship, near 41°N, 162°E, stared into 30-ft waves that continued into the next day.

Figure 40. --A typical extratropical storm.

At 1200 on the 12th, the 964-mb storm was crossing into the Bering Sea. The YOZAN MARU, 450 mi southwest of the LOW, had been taking 54-kn winds and 26-ft seas and swells on her starboard side. The LOW was moving slowly across the Bering Sea. Gale-force winds were blowing along the coastal stations, and isolated ship reports indicated seas up to 25 ft. On the 15th the LOW started breaking down rapidly, and it disappeared by the 16th.

This storm was a Japanese export. It was shipped from northern Honshu late on the 14th. On the 16th there were two reports of 16-ft waves. At 1200 the 986-mb LOW was near 47°N, 169°E. The storm was moving almost due east with generally gale-force winds. At 1800 on the 17th, the HARFLEET (40.7°N, 179°E) was sailing into 33-ft swells. The NORTHERLY TRADER was only about 60 mi from the center at 0000 on the 18th with 20-ft seas and 28-ft swells. Twenty-four hours later she still had 26-ft waves. On the 19th

the storm headed northward south of Dutch Harbor; it dissipated near the Pribilof Islands on the 20th.

This was mainly an inland sea storm. It originated over the East China Sea on the 19th. On the 20th it was moving over the Sea of Japan, and by 0000 on the 21st had merged with another LOW coming out of Manchuria. At that time it was 974 mb near 46°N, 142°E. Several Russian ships in the vicinity of the Kuril Islands reported 50-kn winds. At 0600 the KOREAN MAIL (43°N, 147°E) was bounced by 55-kn winds and 28-ft seas. At 1800 the VASSILII BLIOUKHER, at 42.4°N, 143.7°E, fought 62-kn winds. At 0000 on the 22d, the 968-mb LOW was over northern Sakhalin Island. Late that day it turned eastward, then southward, as it rapidly filled on the 23d.

A LOW formed at the point of occlusion of a front on the 26th near 38°N, 168°E. It was not until 60 hr later that it started to deepen significantly. At 0000 on the 29th, it was 990 mb near 46°N, 173°W. Two ships reported 21-ft swells. At 1200 the pressure was 970 mb. No ships reported in the normally high-wind southwest quadrant. By 0000 on the 30th, the LOW was near 51°N, 148°W, at 962 mb (fig. 41). The SRETENSK, near 48°N, 150°W, battled 46-kn winds blowing 33-ft seas from 280° with 33-ft swells from 240°. The SINCERE, 250 mi northwest of the center, fought 52-kn northerly winds. At 0600 the CHITA MARU, 180 mi to the south, topped the others with 60 kn. At 1200 the SRETENSK was still having problems with 30-ft seas and 33-ft swells. The VANCOUVER, near 50°N, 140°W, was sailing into 34-ft swells. At 56°N, 148°W, the PHILADELPHIA was rolled by 60-kn winds and 20-ft seas. Her sea-level pressure was 963.8 mb, but another ship, the CHADRINSK, reported 957.8 mb even closer to the 956-mb center. The winds and seas were light, but the swells were 16 ft. High seas and swells favored the southeast quadrant at this time. By November 1, the storm quickly broke up as it moved into Cook Inlet.

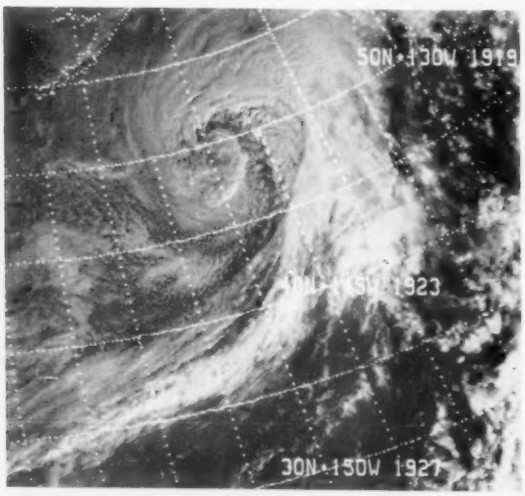

Figure 41.--Various levels and types of clouds are easily discernible in this image with a low Sun angle.

Early on the 30th, the area around Korea, southern Japan, and the East China Sea was covered by a weak pressure gradient. By 1200 a LOW had formed over Korea. The center moved over Hokkaido late on the 31st. At 1200 on November 1, the central pressure had decreased to 985 mb. The RADE KONCAR, at 38.2°N, 148.2°E, was caught in 74-kn thunderstorm winds. At 1800 the PETR ILICHYOV reported 58-kn westerly winds at 45°N, 148°E. The BREWSTER found 60 kn farther south at 41.4°N at 0000 on the 2d. At 1200 the HAKUZAN MARU had 33-ft swells pounding her starboard side at 44.6°N, 159°E. At 0000 on the 3d (fig. 42), the PACBARON, near 49°N, 162°E, fought 55-kn winds, 20-ft seas, and 23-ft swells. By 1200 the LOW was 970 mb near 54°N, 175°E.

The 0000 reports on the 4th indicated two ships with seas and swells up to 26 ft south of the center. They were also reporting 45- and 55-kn winds. At 1200 the NISSHIN MARU reported 44-ft seas in the vicinity of 52.5°N, 170°E, as the storm was breaking up.

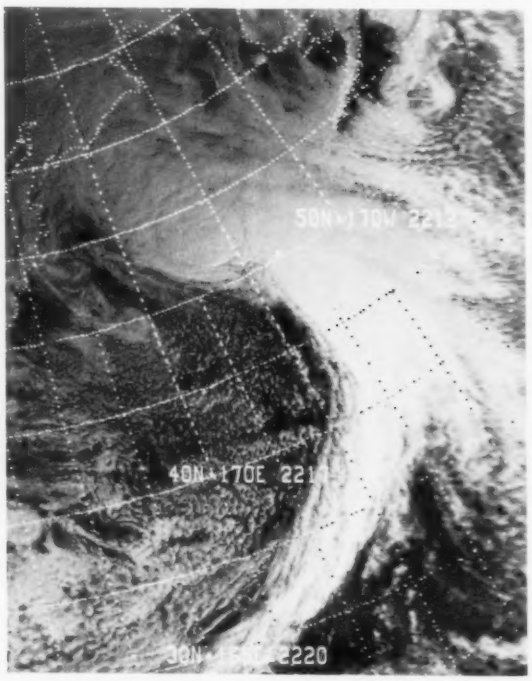

Figure 42.--Clouds are no indication of heavy weather. Both ships were under partly cloudy skies when they encountered high winds and waves.

Tropical Cyclones, Western Pacific--Louise was born in the Caroline Islands on the 30th. By the 1st she was a full-fledged typhoon. Moving west-northwestward, she continued to intensify. Before the 2d was through, Louise was a supertyphoon. Winds of 135 kn blew around her center, which was located near 14°N, 131°E. Gusts were estimated at 165 kn and gales extended out 375 mi in the northern semicircle and 175 mi to the south. Louise gradually recurved to the

north, then to the northeast. She remained about 250 mi east of the Philippines and 150 mi off the Ryukyu Islands. Louise crossed the 20th parallel near 127°E late on the 4th. She remained at super strength (130 kn) through the 4th, and winds stayed above 100 kn until late on the 6th as she approached the 30th parallel near 137°E.

On the 5th (fig. 43) the ASIAN RENOWN, HOLLANDS BURCHT, and the AKADEMIK KOROLYOV all encountered 35- to 40-kn winds far north of the center; the HOLLANDS BURCHT also reported 26-ft swells. By this time she was turning extratropical. On the 7th Louise was a potent extratropical storm.

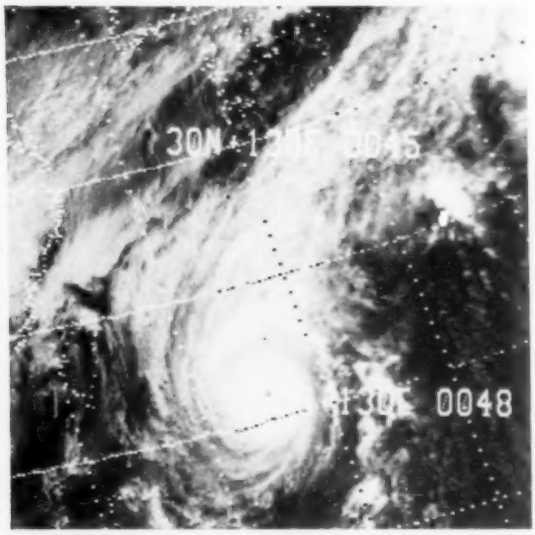

Figure 43.--Supertyphoon Louise just past her peak retains her classic shape on the 5th.

Tropical Cyclones, Eastern Pacific--Naomi, the fourth tropical cyclone to hit the west coast of Mexico this season, was first detected near 15°N, 115°W, on the 25th. This was farther west than the other three (Kathleen, Liza, and Madeline). Naomi moved northward, then northeastward. Maximum winds reached 45 kn on the 27th as she traveled through the Islas Revilla Gigedo. Early on the 29th, Naomi passed 100 mi south of Baja California on her way to Mazatlan on the Mexican mainland. Before the day was over, Naomi was breaking up in the Sierra Madres.

Casualties--The 6,753-ton GREAT GLORY encountered heavy weather on the 1st enroute from Tampa to Japan. The vessel deviated to Honolulu and arrived on the 29th.

The ORIENTAL FINANCIER arrived at Yokohama about the 27th with two survivors of a pleasure craft that sank on a trip from Hawaii to San Francisco. A man and woman of five passengers were spotted adrift in a liferaft on the 19th. Their boat had sunk 3 weeks earlier. The Panamanian freighter LAKELAND (2,376 tons) went aground in rough seas off Tenno of Akita Prefecture.

ROUGH LOG, NOVEMBER 1976--The number of individual storms this month was fewer than normal, but the storms were generally large in size. The tracks did not follow climatology very well. There were two primary tracks; both originated in the Sea of Japan. One branch traced northeastward to the western Bering Sea. The other traced an easterly path until crossing the Date Line, then turned northeastward and then northward into the Gulf of Alaska. A secondary track from the vicinity of 40°N, 145°W, tracked into British Columbia.

The pressure pattern was deeper and more compact and rounded. There was only one 994-mb center for the Aleutian Low versus the normal three along approximately 53°N. This month's center was near 54°N, 160°W, not far from the climatic normal location of the center Low at 1002 mb. The Pacific High was split into two centers, both slightly higher in pressure than the climatic normal. The eastern 1021-mb center was near 33°N, 130°W. The western 1022-mb center, near 30°N, 170°E, was the most anomalous of the two. The split in the High was the consequence of the Aleutian Low being more rounded, rather than an east-west oval, resulting in a sharper trough that extended about 10° latitude farther south. A 1025-mb High was centered over western Montana.

There were two major anomaly centers that were a direct result of or directly affected the storms this month. A negative 10-mb center was near 51°N, 164°W, and a positive 8-mb center was near 55°N, 128°W. Both centers were large. There also was a positive 4-mb center near 30°N, 170°E.

The upper air showed two major troughs, both sharper than normal. One paralleled the Asian coast, and the other was from an anomalous low center near Dutch Harbor south-southeastward toward 30°N, 150°W. The normal ridge over the Rocky Mountains was higher and sharper than normal.

There was one tropical cyclone, typhoon Marge, over the western ocean.

Extratropical Cyclones--A high-pressure center moved over Japan on the 2d, and a LOW formed over the Sea of Japan on a weak front on the 3d. By 1200 on the 4th, it was 984 mb near 49°N, 151°E, with a good circulation moving northeastward. At 1800 the PRIMORSK discovered 52-kn westerly winds over the Sea of Okhotsk. At 0000 on the 5th, the RADE KONCAR was sailing near 47°N, 171°E, with 60-kn southwesterly winds on her stern. The NISSHIN MARU No. 2 plowed into 50-kn winds and 33-ft swells south of the LOW at 1200. At 1800 they were 70 kn and 46 ft.

At 0000 on the 6th, the LOW was 964 mb near 60.5°N, 178°E. The ORIENTAL was 600 mi to the south with 50-kn westerly winds and 33-ft seas and swells. The NISSHIN MARU No. 3 fought 50-kn winds from the west-southwest and 46-ft swells at 50.6°N, 167.5°E. The PACGLORY had 54 kn from the same direction and 41-ft swells near 50°N, 170°E.

On the 7th this LOW dominated the circulation north of 45°N (fig. 44). The only other LOW of significance over the North Pacific was tropical storm Louise south of Honshu. There were three widespread reports of 60-kn winds--the JAMSONS (47.8°N, 152.5°W), the RADE KONCAR (49.6°N, 174.6°W), and another ship at 38.7°N, 176.7°E. There were also reports of 20- to 30-ft waves.

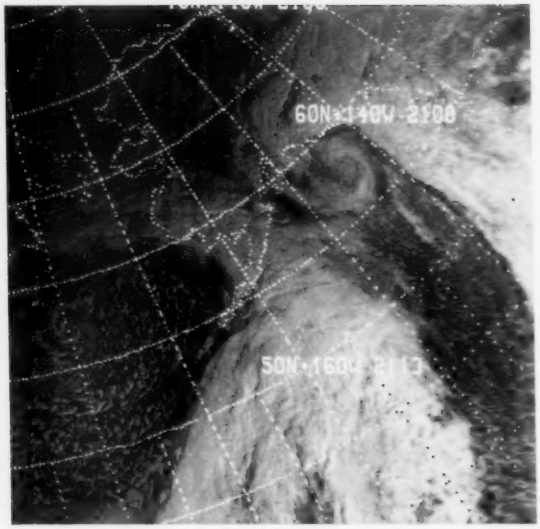

Figure 44.--The LOW is centered near 57°N, 180°, at this time. A small secondary cyclonic circulation is visible over the Gulf of Alaska.

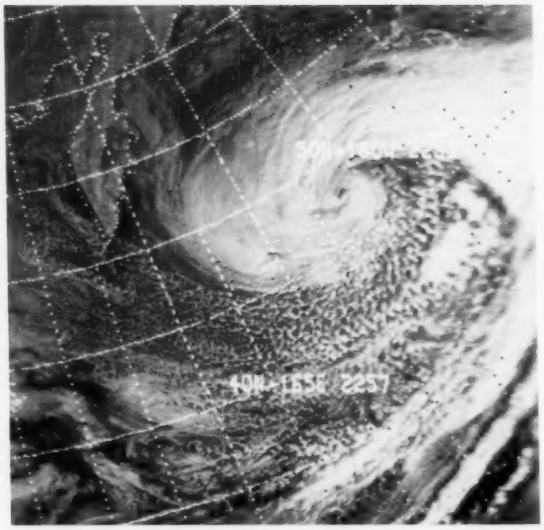

Figure 45.--The whirlpool of air as it looked from space. Twenty-four hours later, the CARNELIAN-1 was a victim of the storm.

Late on the 7th, the LOW turned northwestward and then stalled near 62°N, 179°W, on the 8th and 9th. At 1200 on the 8th, the PHILADELPHIA, at 57.7°N, 148.6°W, was crashing into 46-ft swells. Even though the LOW was filling, far back to the west near 48°N, 166°E, a ship had 55-kn westerly winds and 20-ft seas. By the 10th another LOW had become dominant.

This vicious storm was the result of the combining of two LOWs, the extratropical remnants of typhoon Louise and a LOW that formed over Hokkaido on the 8th. They combined at 0000 on the 10th. At 0000 on the 9th, the ORIENTAL was southwest of the northern LOW with 60-kn northwesterlies. At 0600 both the NISSHIN MARU No. 2 (46°N, 158°E) and the PRESIDENT KENNEDY (37°N, 159°E) fought 70-kn northwesterly winds and waves of 23 ft and 33 ft, respectively.

The 0000 analysis of the 10th indicated a large LOW at 47.5°N, 177°E, with an exceedingly low pressure of 940 mb (fig. 45). A ship identified as SLKF was at 46.4°N, 178.2°E, with a pressure of 947 mb and 50-kn winds. The following are some of the higher wind and wave reports: JAMSONS (43°N, 170°W) - 80 kn, 33 ft; KATHRYN MARU (45°N, 166°E) - 86 kn, 39 ft; RYOKO MARU (45°N, 170°E) - 60 kn, 46 ft; SHUNYO MARU (41°N, 173°E) - 50 kn, 43 ft. At 1200 the LOW was analyzed as 938 mb. The SHUNYO MARU was now fighting 46-ft swells about 350 mi south-southwest of the storm's center. At 0000 on the 11th, the following ships were battered by high swell waves: CRYSTAL REED (35°N, 179°W), 41 ft; HARFLEUR (34°N, 175°W), 39 ft; TUBARAO MARU (40°N, 173°W), 46 ft. The wind reports had slacked to 50 kn or less. At 0600 the HAWAIIAN PROGRESS (34°N, 179°E) found 36-ft seas and swells. At 1800 the LOW was 963 mb near 49°N, 163°W. At 1815 the CARNELIAN-1 reported trouble in a radio message after a deckload of lumber broke loose and crashed over the side (cover). At about 2100 the vessel's radio operator left his post to stand by his lifeboat station. The CARNELIAN-1 sank about 2,200 km northwest of Honolulu. The ship was approximately 800 mi southwest of the storm's center. Among those ships that responded to the distress call were the HUNTER and WISTERIA which picked up 14 survivors with one known dead. Eighteen other crewmen were missing. A U.S. Coast Guard plane spotted crewmen clinging to logs, atop an overturned lifeboat, and in rubber rafts dropped by the plane. The SHUNYO MARU, which had experienced 46-ft waves earlier, arrived on the scene after dawn on the 12th, and the cutter MELLON arrived from Alaska on the afternoon of the 13th.

At 1800 these ships reported high waves: AGANO MARU (35°N, 166°W), 33 ft; HARFLEET (45°N, 159°W), 41 ft; THOMAS E. CUFFE (37°N, 164°W), 33 ft; GOTZ (32°N, 177°W), 30 ft. At 0000 on the 12th, the SHUNYO MARU was at 37.8°N, 175.3°W, with only 30-kn winds, but the swells were 30 ft. The greatest number of high-wave reports were coming from the southeast quadrant of the storm between longitudes 150° and 160°W.

By 1200 on the 12th, the storm had filled to 970 mb and was weakening. This was aided by a frontal wave which was traveling eastward about 900 mi south of the center. A ship reported 33-ft swells near 40°N, 178°W, south of the frontal wave. A monstrous 30-ft surf hit Oahu and the north and northwest shores of the Islands on the 12th. On the 13th the storm's center crossed into the Bering Sea, but an extremely long fetch still existed from Kamchatka to 30°N latitude. On the 14th the frontal wave, now a large storm itself, moved into the Gulf of Alaska and became the dominant factor. At 1800 on the 14th, OWS Papa measured 55-kn winds and 30-ft seas with that LOW.

This was another very large storm, but it did not get nearly as deep as the previous storms, and it tracked farther north after deepening. It formed over the Sea of Japan on the 13th and moved northeastward over the Sea of Okhotsk. On the 14th two ships reported 50-kn winds southeast and northeast of the center. At 0000 on the 15th, a ship near Ostrov Iturup fought 66-kn winds.

By 0000 on the 16th, the LOW was 964 mb over the east coast of Kamchatka. The JAPAN CARRYALL (50°N, 164°E) and the SHOFUKU MARU (49°N, 165°E) both reported 60-kn winds and waves to 33 ft. At 0600 the SHOFUKU was smashed by 36-ft waves. On the 17th the WORLD PRIDE, near 51°N, 174°E, was sailing into 50-kn westerly winds and 33-ft waves. Waves of 20 to 25 ft were reported by several ships southwest of the center. The storm dominated the northern ocean from Kamchatka to British Columbia and as far south as 35°N in the central ocean (fig. 46).

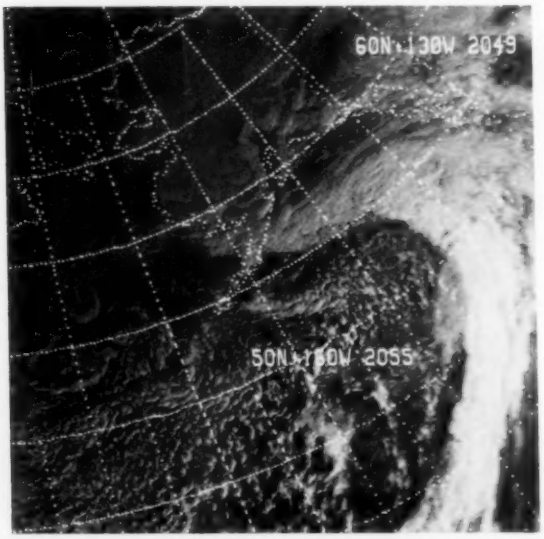

Figure 46.--The center of circulation of the 970-mb storm was near 55°N, 180°, at this time.

On the 18th the storm was in the decaying stage as a secondary LOW formed near Kodiak Island. By the 20th it was gone.

This LOW formed on a trough line of the previous storm on the 19th. It scooted rapidly northeastward. The RADE KONCAR was tossed by 75-kn westerly winds near 42°N, 149°W, with 21-ft waves early on the 20th. At 1200 the 972-mb LOW was near 52°N, 146°W. The NEWARK (53.7°N, 136.3°W) had 60-kn southeasterly winds and 25-ft seas and swells at 1800. The PORTLAND suffered 60-kn winds, 15-ft seas, and 25-ft swells as she headed toward Cook Inlet. The CHEVRON MISSISSIPPI was negotiating the entrance to Cook Inlet with 50-kn easterly winds and 16-ft waves at 1200 on the 21st. Another LOW was moving into the Gulf of Alaska and, on the 22d, took over the circulation.

This LOW started on the 21st southeast of Hokkaido over the Japan Trench. It moved rapidly eastward with little change under zonal flow. Late on the 22d, it turned southeastward and started to expand its area of influence. At 1800 on the 23d, the PRESIDENT MADISON, near 35°N, 171.5°W, encountered 55-kn northwesterly winds and 30-ft seas. By 0000 on the 24th, the LOW was 980 mb near 37°N, 167°W. At that time the MADISON was headed into 60-kn winds and 34-ft seas.

Other ships were suffering as well. The ARNOLD MAERSK had 55-kn winds and 30-ft seas on her port side at 1200 on the 24th. At 1800 and at 0000 the next day, she was battered by 60-kn northerly winds; the seas were coded as 49 and 46 ft, respectively. About 180 mi south of the center, another ship had 50-kn winds and 30-ft waves from the west-northwest. The pressure was 974 mb at 0000.

Late on the 25th, a new LOW center formed north of this one and rapidly became the major storm. Another LOW was approaching from the west with 45- to 55-kn winds south of its center. By 1200 on the 26th, the original LOW no longer existed, and the 0000 chart of the 27th indicated only one large LOW at 968 mb near 53°N, 167°W.

At 1800 on the 26th, a SHIP at 56.5°N, 170.4°W, had 60-kn northeasterly winds. At 0000 on the 27th, the ALEUTIAN DEVELOPER was north of Unalaska Island with bone-chilling, 66-kn winds. The KIKUKO MARU, 200 mi to the west, fought 33-ft swells from the northeast. Another ship near the Pribilof Islands had below-freezing 50-kn winds and 33-ft seas. Fishing vessels off the Siberian coast were fighting 40- to 50-kn winds.

The LOW was moving westward, which is usually deadly as they quickly weaken and fill. The exstorm was last identified south of its original position at about the same longitude.

Tropical Cyclones, Western Pacific--Marge came to life in the western Carolines on the 6th. Moving northwestward, she took 2 days to reach tropical storm strength, near 18°N, 128°E. The following day Marge blew at typhoon strength for a few hours before returning to tropical storm intensity. She turned northward and moved through the Ryukyu Islands, west of Okinawa on the 9th. She continued to weaken before turning extratropical in the East China Sea late on the 10th.

Casualties--The Norwegian HOEGH ORRIS (6,705 tons) struck a pier at Seattle in heavy fog on the 10th. A 75-ft section of the pier was demolished. One of six crewmen was rescued after the 486-ton FUJI MARU No. 3 sank in stormy weather off eastern Kyushu on the 14th.

Marine Weather Diary

NORTH ATLANTIC, FEBRUARY

WEATHER. Usually the weather over the North Atlantic during February is a continuation of the storminess characteristic of January, and there are years when February weather is the most severe of winter. The average pressure distribution remains quite similar to that of January. The Icelandic Low fills to 1004 mb and is located near 60°N, 40°W. The central pressure of the Azores High drops to 1021 mb near 32°N, 22°W. This reduction in the average north-south pressure gradient is caused both by LOWs being less intense on the average during February, and by the more frequent appearance toward the advent of spring of a blocking HIGH at higher latitudes.

WINDS. Over most of the ocean north of 40°N, the prevailing winds are westerly. The winds over the Norwegian Sea are variable. North of 60°N, between Greenland and Norway, the winds vary about equally from westerly to southerly. West of the Bay of Biscay, the winds are variable. Between 25° and 40°N, the wind direction favors the southwest quadrant in the Atlantic. The direction along the Atlantic Coast of the United States is northwesterly to variable off Florida. Over the Gulf of Mexico it is northerly to southeasterly. Westerly to northwesterly winds dominate the Mediterranean Sea. Force 3 to 5 winds are the most common except off the coast of the Middle Atlantic States, where force 4 to 6 winds prevail. In the ocean bounded by approximately 45°N, 30°W, the Denmark Strait, and the Labrador Sea, force 5 to 7 prevail. The "northeast trades," 25°N to the Equator, blow 65 percent of the time with speeds of force 3 to 5.

GALES. Winds of force 8 or greater occur over 20 percent of the time in an area south of Iceland to south and east of Greenland to the Labrador Coast north of Belle Isle. Another area of gale-force winds is east of Newfoundland, centered about 48°N, 36°W, and 5° latitude in radius. Another area is over the Gulf of Lions. The 10 percent occurrence line extends from about Cabo Finisterre to about 500 mi off Cape Hatteras where it turns northeastward to parallel the coast.

EXTRATROPICAL CYCLONES. This month LOWs form most frequently 150 to 250 mi off the East Coast, from Cape Hatteras northeastward to about the latitude of Cape Cod. This is part of a large area of cyclogenesis that extends from the Gulf Coast of the United States to the Bay of Fundy. Another major area of cyclone development and the path they follow is from the Grand Banks northeastward to Iceland. There also is a primary track northward from Newfoundland to southern Greenland, where it splits into the Labrador Sea and toward Iceland. Other tracks are over the northeastern ocean from west of Ireland toward the Barents Sea, from the English Channel across the Gulf of Finland, and from the Gulf of Lions southeastward across the Mediterranean Sea. The Gulf of Genoa is also a favorite area of cyclogenesis.

SEA HEIGHTS. Seas 12 ft or higher can be expected 10 percent of more of the time north of a line from a couple of hundred miles east of Cape Hatteras to Cape Finisterre, Spain. On the Mediterranean, 10-percent frequencies lie inside an ellipse stretching from Barcelona, Spain, to Crete and then northwestward to Sicily, Sardinia, and the Gulf of Genoa. Another small area of 10-percent frequency lies between Crete and Turkey. The coast of Colombia still hosts a 10-percent line off Barranquilla. An area of over 20 percent is located off the central coast of Norway. The highest frequencies of greater than 30 percent are found over a triangular area between 57°N, 43°W; 45°N, 42°W; and 62°N, 13°W; and in the Denmark Strait.

VISIBILITY. The frequency of low visibility (less than 2 mi) reaches 10 percent or more from Halifax, Nova Scotia, northeastward to a point near 50°N, 40°W, and then northwestward to near Cape Mercy. It also reaches 10 percent on the southeastern North Sea and over the waters around the Faeroe Islands and eastern Iceland. The frequency increases to more than 20 percent inside a coastal region from Cape St. John, Newfoundland, to Resolution Island and then southward to Ungava Bay, and over the Norwegian Sea north of about 72°N.

NORTH PACIFIC, FEBRUARY

WEATHER. February weather in general can be as rough as any month of the year over the middle and higher latitudes. The average central pressure of the Aleutian Low is 1000 mb and is near 51°N, 172°E. The subtropical Pacific High is 1020 mb and centered near 31°N, 138°W. A ridge of high pressure extends eastward from the central China coast. The 1033-mb Siberian High is centered over western Mongolia. The weather regimes are controlled by these three features.

WINDS. Westerly winds prevail over much of the ocean north of 30°N and west of 180°. Northerly winds dominate the East China Sea. Winds are variable over the central Aleutians, southeasterly over the western Aleutians, and easterly near the Pribilof Islands. From the Gulf of Alaska southward to near 40°N and east of 180°, winds are mostly southerly to southwesterly, although other directions are common during the frequent passage of LOWs. Over the extreme northern Gulf of Alaska, the prevailing winds are easterly, and northerly winds are very pronounced over the Bering Sea north of 60°N. The average speed of winds north of 30°N is force 4 to 6, although east of Honshu the wind blows at force 6 or 7, 41 percent of the time. The "northeast trades" extend northward to more than 20°N over most of the western and central ocean and to 30°N over eastern waters; south of 20°N, these winds are very steady. The wind speeds in the trades range from force 3 to 5. The "northeast monsoon" is steady over the South China Sea and the Philippine Sea south of 30°N and west of 150°E. Winds are quite variable over the eastern North Pacific between 30° and 40°N, southwesterly over the east-central ocean be-

tween 30° and 45°N, and variable over west-central waters between 25° and 30°N, and 135°E and 180°. Wind speeds over these areas usually average force 4. Northerly winds predominate over the Gulf of Tehuantepec, and in 71 percent of the observations they range between force 2 and 6.

GALES. The frequency of gales near and above 10 percent affects most noncoastal areas south of the Aleutians and north of a line from the waters southeast of Honshu to a point south of the Queen Charlotte Islands and west of Washington State. A maximum incidence of over 20 percent is found over a 200-mi-wide band 600 to 1,000 mi southeast of the southern tip of Kamchatka, an area east of northern Honshu near 37°N, 155°E, and south of the Gulf of Alaska near 52°N, 145°W. Gale-force northerly winds are encountered more than 10 percent of the time by vessels plying the Gulf of Tehuantepec off southern Mexico. These high winds occur when strong northers from the Gulf of Mexico funnel across the isthmus to the Pacific. In extreme cases, they may be felt more than 200 mi out at sea.

EXTRATROPICAL CYCLONES. The storms predominantly follow a northeasterly track. The principal areas of cyclogenesis are off Hokkaido, the East China Sea, about 600 mi south of Unimak Island, and about the same distance southwest of Vancouver Island. Secondary tracks converge 350 mi east-northeast of Hokkaido and head east-northeastward toward the Rat Islands in the western Aleutians. A primary track extends northeastward from the East China Sea to the waters south of the western Aleutians and then runs parallel to that island chain to the Gulf of Alaska. The passage of LOWs over the Gulf of Alaska along the track described above and the one entering from the southwest is more confined to the western portion of the Gulf. The storm path approaching Vancouver Island from the southwest does not contain a maximum concentration of individual cyclones until it reaches a point 600 mi from that island.

TROPICAL STORM activity is at the annual minimum during February. On the average, one can be expected every 4 yr over western waters. As in the other winter months, the principal region of cyclogenesis is east of the central and southern Philippines. Two out of every seven February tropical storms has reached typhoon intensity in the past.

SEA HEIGHTS. Seas of 12 ft or more are encountered from 10 to 20 percent of the time over most of the ocean area between latitudes 30° and 52°N from 140°W to 145°E. A small area with a similar frequency lies over the waters bounding Taiwan where the "northeast monsoon" blows strongly and steadily. Areas of 20- to 30-percent frequency extend between latitudes 44° and 49°N from 172°E to 153°E, and farther southeast 100 to 200 mi around a line drawn from 35°N, 165°E to 40°N, 175°W.

VISIBILITY. Areas of limited visibility (less than 2 mi) occur in more than 10 percent of the observations north of a line drawn from the Yellow Sea through the Sea of Japan, south of Hokkaido, and then east-northeastward to the Alaska Peninsula. A maximum frequency of over 30 percent surrounds the waters around Ostrov Paramushir, south-southwest of Kamchatka.

NORTH ATLANTIC, MARCH

WEATHER. March is a transition month. The weather retains many of the wintry aspects of January and February and at the same time begins to exhibit some features typical of spring. During the first part of March, the weather is generally a continuation of winter conditions, gradually approaching springlike characteristics near the close of the month. However, wide variations from the climatic averages may be expected, and this pattern is not always the rule. The Icelandic Low (1005 mb) rests southeast of Kap Farvel near 58°N, 40°W, while the Azores High contains two 1020-mb centers southwest of the Azores near 27.5°N, between 35° and 42°W.

WINDS from westerly quadrants generally prevail over the major part of the western North Atlantic north of 30°N. Northerly or northeasterly winds blow more often over the waters between southern Greenland and western Iceland than any other winds from the four cardinal and four intercardinal points of the compass. Winds shift to a southerly component as one moves eastward from 35°W and to variable in direction over the Norwegian Sea east of 5°W. Near the coasts of Morocco and Portugal, northerly winds predominate. South of 30°N, the "northeast trades" are the dominant winds over most of the ocean with few exceptions. East of the Florida coast to about 68°W, wind directions are southeasterly to southerly. There is a strong tendency for easterly and southeasterly winds over the Gulf of Mexico. Over the Mediterranean, westerly to northwesterly winds prevail. For the month as a whole, winds of force 4 to 6 prevail north of 40°N (north of 35°N, west of 40°W) and force 3 to 4 south of 40°N (south of 35°N, west of 40°W).

GALES (force 8 or higher) tend to decrease in strength and frequency during the latter half of March. On the average, gale-force winds have been noted in 10 percent of the ship observations north of a line extending roughly from Cape Hatteras to the Bay of Biscay, excluding the southern Norwegian Sea, the waters south of western Iceland down to 60°N, the seas west of southern Ireland to about 33°W, and the waters east of Newfoundland. A small area of gale frequencies greater than 10 percent covers the Gulf of Lions. The maximum frequency of gale occurrence, 20 percent, may be expected from the southern tip of Greenland south to about 55°N and between 40° and 50°W.

EXTRATROPICAL CYCLONES. Principal storm tracks head from the Great Lakes and the Carolina coast to Newfoundland. From Newfoundland, a primary track curves northward to the west coast of southern Greenland, and another track runs northeastward to Iceland and then into the Barents Sea. Over the Mediterranean area, a primary track extends from the Bay of Biscay east-southeastward to the southern Turkish coast.

TROPICAL CYCLONES. Only one tropical storm, a hurricane in the Lesser Antilles in 1908, has been reported in the North Atlantic in the past 104 yr.

SEA HEIGHTS of 12 ft or more are encountered more than 10 percent of the time north of a line from about 150 mi east of Cape Hatteras to Brest, France; in a small area northwest of Barranquilla, Colombia; in the Strait of Otranto between Italy and Albania; and from the coast of Sardinia northwestward to France. A large irregularly shaped area of 20-percent frequency lies in the open ocean bounded roughly by the following coordinates: 60°N, 55°W; 68°N, 25°W; 60°N, 10°W; 43°N, 43°W. Smaller areas of 20-percent frequency lie northeast of Bermuda, west of central Norway, and in the Gulf of Lions.

VISIBILITY less than 2 mi occurs 10 percent or more of the time over a 400-mi-wide elliptically shaped area extending northeast-southwest from 55°N, 40°W to 42°N, 58°W; over an area of the Labrador Sea from Cape Mercy to Cod Island; over the North Sea from southern Norway southeastward to Denmark and Sweden; and north of a line extending from southern Greenland to north of Iceland and then to the Barents Sea.

NORTH PACIFIC, MARCH

WEATHER. March is normally considered one of the transitional months between winter and spring over the North Pacific. Compared to the North Atlantic, weather improvement is somehwat delayed by the vast expanse of the ocean and the lingering winter climate over Siberia. Stormy weather is about as frequent as in the preceding month along the northern routes, especially from the western Aleutians southwestward to the vicinity of Japan. The 1005-mb Aleutian Low lies about 250 mi south of the Komandorskiye Islands and the Pacific High (1022 mb) rests near 33°N, 144°W.

WINDS. From about 40° to 60°N, winds from the westerly quarter are most frequent, although winds are variable north of the Aleutians and easterly over the Gulf of Alaska. In 40 to more than 60 percent of the observations, the wind force is 4 to 6. However, near the North American coast the most frequent wind speeds are force 4 to 5. West to north winds are most prevalent in Japanese waters south of 40°N where more than 50 percent of all winds vary between force 4 and 6. During March, the northeast monsoon continues to prevail along the Asiatic coast south of Shanghai and over Philippine waters. From 25° to 40°N, wind directions are variable, and the force is from 3 to 5 more than 50 percent of the time. The "northeast trades" are the dominant winds from 25°N to the Equator and extend northward to about 30°N over the eastern part of the ocean. The usual wind speeds, force 3 to 5, persist more than 60 percent of the time over the ocean area under the influence fo the trades. Northerly force 2 to 3 winds blow 40 percent of the time over the Mexican waters out from the Gulf of Tehuantepec.

GALES. In the central and western North Pacific, gales may be expected as far south as 30°N. In this area, north of 35°N and west of 175°W, 10 to more than 20 percent of ship reports contain winds of force 8 or higher. Over the eastern part of the ocean east of 175°W, there is a large reduction in gale frequencies compared to February, and occurrences are generally confined to latitudes north of 35°N. Percentage frequencies of gales in the central Gulf of Alaska, 10 to 20 percent in the preceding month, drop to 5 to 10 percent during March. Gales over the Gulf of Tehuantepec may be expected more than 5 percent but less than 10 percent of the time.

EXTRATROPICAL CYCLONES. The greatest frequency of cyclogenesis in the Northern Hemisphere takes place in the area off the Ryukyus in March. These storms run northeastward to an area about 250 mi east of Hokkaido where they join another primary track coming from La Perouse Strait between Sakhalin and Hokkaido. East of Hokkaido, the primary paths head northeastward to the western Aleutians where they either continue into the eastern Bering Sea or curve to the east-northeast and parallel the Aleutians and Alaska Peninsula until reaching the Gulf of Alaska. Another track extends from 50°N, 160°W, to the Gulf of Alaska. A storm track heads east-southeastward from the Gulf of Alaska to the Alaska Panhandle.

TROPICAL CYCLONES are infrequent during March. A tropical storm can be looked for once every 2 yr over the western ocean. Half of these tropical storms develop further into typhoons. Tropical cyclones during March usually sprout up east of the central and southern Philippines and west of 170°W.

SEA HEIGHTS of at least 12 ft occur more than 10 percent of the time in a somewhat rectangular area bounded approximately by 50° and 33°N, and 155°E and 140°W.

VISIBILITY. The southern limit of 10-percent frequency of low visibility (less than 2 mi) extends from Mys Alevina, Siberia, southward to 42°N, 160°E, and then northeastward to west of Kodiak Island. This frequency increases to more than 20 percent from the waters around the northern Kurils northeastward to the Komandorskiye Islands and then northwestward to Mys Ozernoy.

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NOAA National Weather Service Port Meteorological Offices have personnel who visit ships in port to check and calibrate barometers and other meteorological instruments. In addition, port meteorologists assist masters and mates with problems regarding weather observations, preparation of weather maps, and forecasts. Meteorological manuals, forms, and some instruments are also provided.

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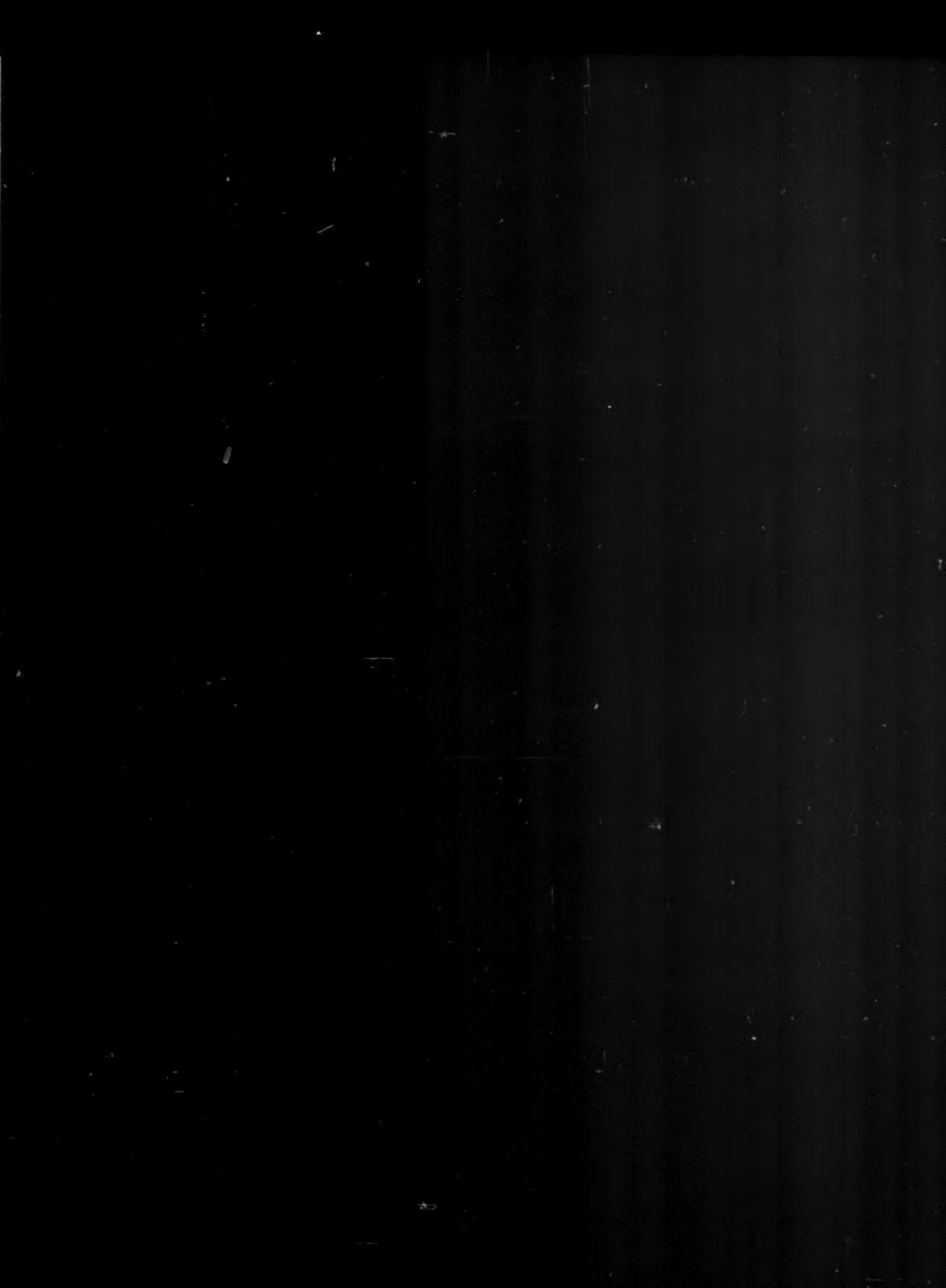
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